BEFORE THE PUBLIC UTILITIES COMMISSION
OF THE STATE OF COLORADO

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IN THE MATTER OF THE APPLICATION OF PUBLIC SERVICE COMPANY OF COLORADO FOR APPROVAL OF A NUMBER OF STRATEGIC ISSUES RELATING TO ITS ELECTRIC AND GAS DEMAND DE MANAGEMENT PLAN	)))))))	PROCEEDING NO. 17A-0462EG

CORRECTED DIRECT TESTIMONY AND ATTACHMENTS OF SHAWN M. WHITE

ON

BEHALF OF

PUBLIC SERVICE COMPANY OF COLORADO

July 3, 2017

**BEFORE THE PUBLIC UTILITIES COMMISSION
OF THE STATE OF COLORADO**

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IN THE MATTER OF THE APPLICATION OF PUBLIC SERVICE COMPANY OF COLORADO FOR APPROVAL OF A NUMBER OF STRATEGIC ISSUES RELATING TO ITS ELECTRIC AND GAS DEMAND SIDE MANAGEMENT PLAN	**) PROCEEDING NO. 17A-0462EG**

SUMMARY OF THE CORRECTED DIRECT TESTIMONY OF SHAWN M. WHITE

Mr. Shawn M. White is Manager, Demand Side Management ("DSM") and Renewable Regulatory Strategy & Planning of Xcel Energy Services Inc. In this position, he is responsible for ensuring Xcel Energy's energy efficiency and demand response programs adhere to regulatory policies.

In his testimony, Mr. White explains how Public Service Company of Colorado ("Public Service" or the "Company") measures and reports energy savings and how it designs its energy efficiency portfolio. He also details how the Company ranks amongst its peer utilities in providing DSM programs.

Next, Mr. White presents the Company's 2016 Potential Study and the Company's 2019-2023 DSM forecasts. A potential study takes a high level view of the market to identify possible measures for inclusion in program design and implementation. The 2016 Potential Study suggests that the future potential from traditional energy efficiency is declining. This is generally driven by the expectation that new codes and standards will increase naturally-occurring adoption of energy efficient technologies outside of utility DSM products and programs. A potential study is a useful input in developing an energy efficiency portfolio, but there are practical limitations in how it can be used to develop an energy efficiency portfolio, thus it is only one input of many that can be used to develop an energy efficiency portfolio.

Mr. White then explains that the Company's generation supply portfolio has changed and continues to change to integrate increasing amounts of renewable energy. The changes to the Company's generation portfolio had a number of effects on the Company's DSM programs, most notably in the cost-effectiveness of energy efficiency. The divergence of achievements and benefits had the unintended consequence of increasing volumetric rates to customers. This is because achievements in energy efficiency programs continue to reduce volumetric sales, while system benefits continue to decrease, creating upward pressure on volumetric rates.

Thus, to address the issue, the Company proposes a new path forward that will focus on achieving energy savings where the marginal costs and emissions reductions are greatest. The Company also plans to focus on peak demand reduction through energy efficiency, such as through adopting load shifting measures that move customer usage from high cost or constrained periods to periods of lower cost and constraint.

Mr. White presents several changes the Company is proposing to realign its delivery of energy efficiency and demand response programs to better reflect the current and future landscape for resource planning, renewable integration, and DSM.

First, the Company recommends that its energy efficiency goal be set to the following annual goals:

Table SMW-D-4: Proposed Annual Energy Savings (GWh) Goals

Year	2019	2020	2021	2022	2023	Total
GWh	350	350	325	325	325	1,675

Second, the Company recommends its energy efficiency demand reduction goal continue at the current levels to maintain focus on avoiding the most costly generation.

Table SMW-D-5: Proposed Annual Energy Efficiency Demand Reduction (MW) Goals

Year	2019	2020	2021	2022	2023	Total
MW	65	65	65	65	65	325

Mr. White then addresses avoided emissions from energy efficiency. The method used to determine the avoided emissions from energy efficiency has changed over time given the expected value of avoided emissions. In addition to using emissions in the Modified Total Resource Cost Test and estimating emissions from the DSM Portfolio, the Company proposes to use emissions data to determine the emissions avoidance of individual DSM measures. The Company recommends that new DSM measures that could cost-effectively shift usage be included in the Company's DSM portfolio.

In light of the increasing diversity of generation sources, the timing of the energy savings has a significant effect on the amount of emissions avoided by a DSM measure. Accordingly, to determine the emissions avoidance of individual DSM measures, Mr. White proposes using the hourly marginal energy price to determine the likely generation source of marginal energy each hour.

Mr. White then presents the Company's proposed demand response goals, which are:

Table SMW-D-8: Proposed Demand Response Goals

Year	2019	2020	2021	2022	2023
MW	465	476	489	503	520

These goals are based upon historic achievements and trends in demand response growth, and also reflect the state of the marketplace and make-up of the Company's residential, commercial, and industrial offerings.

Finally, Mr. White discusses several DSM policy issues. These include secondary site savings, commercial and industrial behavioral savings methodology, and the Company's reconsideration of its avoided transmission and distribution study.

In sum, Mr. White recommends that the Commission approve:

- Approval of the Company's proposed modifications to its electric Energy Efficiency goals for 2019 through 2023;
- Approval of the Company's proposed modifications to its Energy Efficiency Demand Reduction goals for 2019 through 2023;
- Approval of the Company's proposed methodology to determine avoided emissions;
- Approval of proposed dispatchable demand response goals for each of the years 2019 through 2023.
- Confirmation that Commission Rule 4750 does not preclude the Company from claiming secondary site savings in its energy, demand, and net benefit calculations; and
- Approval to use an incremental savings method instead of an average savings method to calculate behavioral energy efficiency savings.

**BEFORE THE PUBLIC UTILITIES COMMISSION
OF THE STATE OF COLORADO**

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IN THE MATTER OF THE APPLICATION OF PUBLIC SERVICE COMPANY OF COLORADO FOR APPROVAL OF A NUMBER OF STRATEGIC ISSUES RELATING TO ITS ELECTRIC AND GAS DEMAND SIDE MANAGEMENT PLAN	**) PROCEEDING NO. 17A-0462EG**

CORRECTED DIRECT TESTIMONY AND ATTACHMENTS OF SHAWN M. WHITE

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Attachment SMW-3	Xcel Energy "T&D" Study

GLOSSARY OF ACRONYMS AND DEFINED TERMS

Acronym/Defined Term	Meaning
ACCC	AC Contingency Calculation
ACEEE	American Council for an Energy Efficient Economy
CFL	Compact fluorescent lights
DSM	Demand side management
EIA	Energy Information Administration
EPA	U.S. Environmental Protection Agency
ERP	Electric resource plan
LED	Light-emitting diode
M&V	Measurement and verification
MTRC	Modified total resource cost test
NSP-MN	Northern States Power – Minnesota
NTG	Net-to-gross
Navigant	Navigant Consulting, Inc.
RMRG	Rocky Mountain Reserve Group
UCT	Utility cost test
VFD	Variable frequency drive
WACC	Weighted average cost of capital
XES	Xcel Energy Services Inc.
Xcel Energy	Xcel Energy Inc.

**BEFORE THE PUBLIC UTILITIES COMMISSION
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CORRECTED DIRECT TESTIMONY AND ATTACHMENTS OF SHAWN M. WHITE

I. INTRODUCTION, QUALIFICATIONS, PURPOSE OF TESTIMONY, RECOMMENDATIONS

Q. PLEASE STATE YOUR NAME AND BUSINESS ADDRESS.

A. My name is Shawn M. White. My business address is 401 Nicollet Mall, Minneapolis, Minnesota 55401.

Q. BY WHOM ARE YOU EMPLOYED AND IN WHAT POSITION?

A. I am employed by Xcel Energy Services Inc. ("XES") as Manager, Demand Side Management ("DSM") and Renewable Regulatory Strategy & Planning. XES is a wholly-owned subsidiary of Xcel Energy Inc. ("Xcel Energy"), and provides an array of support services to Public Service Company of Colorado ("Public Service" or the "Company") and the other utility operating company subsidiaries of Xcel Energy on a coordinated basis.

Q. ON WHOSE BEHALF ARE YOU TESTIFYING IN THE PROCEEDING?

A. I am testifying on behalf of Public Service.

Q. PLEASE SUMMARIZE YOUR RESPONSIBILITIES AND QUALIFICATIONS.

A. As the Manager, DSM and Renewable Regulatory Strategy & Planning, I am responsible for ensuring Xcel Energy's energy efficiency and demand response programs adhere to regulatory policies. In this capacity, I provide strategic direction and oversee a team that: (i) develops long-range goals for the portfolio of programs for resource planning; (ii) tracks and reports energy efficiency achievements and financial operations; (iii) prepares DSM regulatory reports and filings; and (iv) analyzes the cost-effectiveness of energy efficiency and load management programs and portfolios in five of XES's state jurisdictions with active energy efficiency programs or pending legislation. A description of my qualifications, duties, and responsibilities is set forth after the conclusion of my Direct Testimony in my Statement of Qualifications.

Q. WHAT IS THE PURPOSE OF YOUR DIRECT TESTIMONY?

A. In my testimony, I first explain how the Company measures and reports energy savings and how it designs its energy efficiency portfolio.

Next, I present the Company's 2016 Potential Study and 2019-2023 DSM forecasts. As ordered in Decision No. C14-0731, Public Service retained Navigant Consulting, Inc. ("Navigant") to conduct its 2016 Potential Study in advance of this Strategic Issues filing. The 2016 Potential Study suggests that the future potential from traditional energy efficiency is declining. This is generally driven by the expectation that new codes and standards will increase naturally-occurring adoption of energy efficient technologies outside of utility DSM products and programs. I explain that although a potential study can be a useful tool, there are practical limitations in how it can be used to develop an energy efficiency portfolio.

I next explain how the Company's generation system has changed and continues to change to integrate increasing amounts of renewable energy. These changes have had a number of effects on the Company's DSM programs, most notably in the cost-effectiveness of energy efficiency. The divergence of achievements and benefits has had the unintended consequence of increasing volumetric rates to customers. To address these issues, the Company proposes a new path forward that will focus on achieving energy savings where the marginal costs and emissions reductions are greatest.

Specifically, the Company will no longer value each kWh the same but instead will accurately value each kWh based upon the marginal type of avoided energy. The Company also plans to focus on peak demand reduction through energy efficiency, such as through adopting load shifting measures that move customer usage from high cost or constrained periods to periods of lower cost and constraint.

Next, I present the Company's proposed annual energy efficiency goals for 2019-2023, which would result in a total savings of 1,675 GWh over the five year period. The Company recommends its energy efficiency demand reduction goal continue at the current level of 65 MW per year to maintain focus on avoiding the most costly generation.

I then address avoided emissions from energy efficiency, and propose to use emissions data to determine the emissions avoidance of individual DSM measures. To determine the emissions avoidance of individual DSM measures, I recommend using the hourly marginal energy price to determine the likely generation source of marginal energy each hour.

Finally, I discuss several DSM policy issues. These include secondary site savings, commercial and industrial behavioral savings methodology, and the Company's reconsideration of its avoided transmission and distribution study.

Q. ARE YOU SPONSORING ANY ATTACHMENTS AS PART OF YOUR DIRECT TESTIMONY?

A. Yes, I am sponsoring Attachments SMW-1, SMW-2, and SMW-3, which were prepared by me or under my direct supervision. Attachment SMW-1 is the 2017 Utility Energy Efficiency Scorecard published by the American Council for an Energy Efficient Economy ("ACEEE"). Attachment SMW-2 is Xcel Energy's 2016 DSM Potential Study Report. Attachment SMW-3 is Xcel Energy's 2016 T&D Study.

Q. WHAT RECOMMENDATIONS ARE YOU MAKING IN YOUR TESTIMONY?

A. The Company recommends that the Commission issue an order granting the following relief:

- Approval of the Company's proposed modifications to its electric Energy Efficiency goals for 2019 through 2023;

Table SMW-D-4: Proposed Annual Energy Savings (GWh) Goals

Year	2019	2020	2021	2022	2023	Total
GWh	350	350	325	325	325	1,675

- Approval of the Company's proposed modifications to its Energy Efficiency Demand Reduction goals for 2019 through 2023;

Table SMW-D-5: Proposed Annual Energy Efficiency Demand Reduction (MW) Goals

Year	2019	2020	2021	2022	2023	Total
MW	65	65	65	65	65	325

- Approval of the Company's proposed methodology to determine avoided emissions;
- Approval of proposed dispatchable demand response goals for each of the years 2019 through 2023;

Table SMW-D-8: Proposed Demand Response Goals

Year	2019	2020	2021	2022	2023
MW	465	476	489	503	520

- Confirmation that Commission Rule 4750 does not preclude the Company from claiming secondary site savings in its energy, demand, and net benefit calculations; and
- Approval to use an incremental savings method instead of an average savings method to calculate behavioral energy efficiency savings.

II. ENERGY EFFICIENCY PORTFOLIO DESIGN AND DEVELOPMENT

Q. WHAT IS THE PURPOSE OF THIS SECTION OF YOUR TESTIMONY?

A. In this section of my testimony, I explain how energy savings are measured and reported, how the Company designs and delivers its energy efficiency portfolio.

A. Energy and Demand Savings Calculations and Reporting

Q. BEFORE DISCUSSING THE POTENTIAL STUDY, CAN YOU PROVIDE SOME BACKGROUND ON HOW THE COMPANY CALCULATES AND REPORTS ENERGY AND DEMAND SAVINGS?

A. Yes. Energy and demand savings are first measured at the "gross level," which includes all savings that have been achieved through energy efficiency program[1] participation. This value does not take into account whether the utility influenced the customer to participate in a program, but only whether the customer participated. Therefore, an adjustment to net savings is necessary to more accurately report utility-influenced efficiency program savings.

Gross savings are then adjusted by a net-to-gross ratio ("NTG") that measures the utility's influence in getting a customer to participate in a DSM program. NTG consists of two components: free-ridership and spillover. Free-ridership accounts for participant activities that may not be directly influenced by an energy efficiency program. Spillover accounts for savings that are not

[1] As described by Company witness Mr. Brockett in Section III of his Direct Testimony, a Program is a collection of similar products targeted to a specific customer segment. The current programs in DSM Plans include Business, Residential, Low-Income, and Indirect.

captured in the gross savings achievement, but were directly influenced by an energy efficiency program.

Q. PLEASE DESCRIBE FREE RIDERSHIP IN MORE DETAIL.

A. A "free rider" is a participant who likely would have taken the same action in the absence of the program, but who nonetheless applies for a rebate. For example, a customer that purchases a high efficiency air conditioner but does not consider any alternative would be a "free rider" to the extent he or she applies for and receives a rebate because the utility's rebate and marketing had no effect on the customer's decision.

As part of the evaluation of an energy efficiency product[2], participating customers are asked how important the utility incentive or rebate was in their decision to purchase the energy efficiency measure[3]. When a customer responds that the incentive or rebate had no influence on their decision, the customer is defined as a free rider. For example, if 20% of customers said the utility program had no effect on their decision, the utility would only claim and report 80% of the gross savings.

[2] As described by Company witness Mr. Brockett in Section III of his Direct Testimony, a product is a collection of similar measures marketed individually or holistically to end-use residential, business, or low-income customers.

[3] As described by Company witness Mr. Brockett in Section III of his Direct Testimony, a measure is a technology, service, or device that enables the end-use customer to reduce their electric energy and peak demand. Examples include water heater blankets within the Home Energy Squad product or ground source heat pumps within the High Efficiency Air Conditioning product.

Q. PLEASE DESCRIBE SPILLOVER IN MORE DETAIL.

A. "Spillover" occurs when non-participants adopt an energy efficiency measure or practice but do not apply for an incentive or rebate. The influence for spillover may come from past experience with a DSM program or from the educational and marketing information provided by the utility. There can be both participant and non-participant spillover effects. For example, if a participating residential customer purchases and installs discounted high efficiency lighting through the Home Lighting and Recycling product and likes the equipment, the customer may look to install more of the same or similar equipment at a later date. However, the customer may go to a retailer that does not participate in the Home Lighting and Recycling product, or the product may not promote that equipment at the time of the follow-up visit. This would result in participant spillover because the product influenced the decision but did not directly account for the sale of efficient equipment.

Spillover may also account for a utility's effect on transforming the market for energy efficiency measures. Market transformation occurs when a measure or service moves from a marginal opportunity in the marketplace to the baseline product or service in the marketplace. A utility may influence market transformation by changing the attitudes and behaviors of market actors such as customers, contractors, distributors, or manufacturers. For example, in the mass market lighting market there has been significant transformation as incandescent bulbs have been replaced, first, by compact fluorescent lights ("CFL") and, most recently, by light emitting diodes ("LED"). The utility has had some effect on this by driving the stocking habits of retailers through its programs and raising awareness with customers through outreach, promotion activities, and marketing.

Q. PLEASE DESCRIBE THE IMPACT OF THE SPILLOVER COMPONENT IN THE DETERMINATION OF THE COMPANY'S NTG RATIO.

A. The factor of spillover in the NTG ratio is best explained through adding spillover to the free-ridership example explained above. If the free ridership value of 20% is identified resulting in a NTG value of 80% and an evaluation identifies a spillover value of 10%, then the new NTG value would increase to 90% to reflect the balance of free ridership (-20%) and spillover (+10%).

B. Benchmarking Performance and Utility Program Delivery

Q. IS THE USE OF NTG ACCEPTED IN OTHER DSM PROGRAMS?

A. Yes, although the use of NTG can vary from state to state. For example, of the five states where Xcel Energy directly implements DSM programs (Minnesota, Colorado, South Dakota, Texas, and New Mexico), NTG is applied in two – Colorado and New Mexico. Therefore, the application of NTG and the factors included in the NTG value and varying DSM policies among states make it difficult to accurately track meaningful comparisons of the reported energy savings achievements of other utilities.

Q. ARE THERE DIFFICULTIES IN COMPARING THE ENERGY SAVINGS ACHIEVEMENTS AND GOALS BETWEEN STATES AND UTILITIES?

A. Yes. It is common for industry studies to attempt to compare different states and utilities in order to determine the "right" level of DSM. While this can be instructive, normalizing achievements across utilities and states is difficult. In addition to the effects of NTG on the savings of other utility programs, other characteristics make comparisons between states and utilities challenging. These characteristics include: state policies such as building codes and fuel switching; whether the goals are expressed at the generator level[4] (includes losses) or at the meter level; the service territory's mix of industrial, commercial, and residential population; energy intensity per square foot; climate differences; and the propensity of the population's acceptance and willingness to adopt energy efficiency opportunities.

For instance, savings achievements for Northern States Power – Minnesota ("NSP-MN") compared to Public Service are affected by differences in the size of each utility's industrial manufacturing sector, the difference in climate, and the application of NTG. Public Service's territory in Colorado has about 5,200 manufacturing customer accounts, whereas NSP-MN has approximately 5,900 accounts. While the number of accounts is only somewhat higher in Minnesota, the size of the accounts, and therefore the opportunity for large energy efficiency projects, is significantly larger, with 7,700 GWh in Minnesota

[4] Goals and savings in Colorado are measured at the generator level.

versus 2,200 GWh in Colorado. This is significant because industrial energy efficiency projects tend to result in large, cost-effective energy savings.

Climate also plays a factor because of the prevalence and run time of air conditioning in Minnesota. The Company's most recent Home Use Study indicates that 73% of NSP-MN customers have air conditioning, compared to only 60% of Public Service's customers. More importantly is the run time, which is a measure of the frequency with which the customer uses the air conditioner. For customers with existing air conditioning systems, the run times in NSP-MN are typically 20% higher than in Colorado.

Q. ARE THERE ANY COMPARISONS OF ENERGY EFFICIENCY PROGRAMS ACROSS STATES?

A. The ACEEE has attempted to normalize some of the key factors, and in those comparisons Public Service ranks very well. In its recently released study, "The 2017 Utility Energy Efficiency Scorecard," Attachment SMW-1, ACEEE compared 51 utilities. Xcel – Colorado (Public Service) was ranked in the top 10, as was Xcel – Minnesota (NSP-MN).

Q. ACCORDING TO ACEEE, WHAT CATEGORIES DID PUBLIC SERVICE RANK HIGH IN AGAINST ITS PEERS?

A. Public Service ranked in the top 10 in the categories of annual energy savings, lifetime energy savings, and deployment of pilots. Of the 51 utilities, Public Service ranked seventh in annual energy savings, fourth in lifetime energy savings, and tenth in pilots offered.

As I will discuss later in my testimony, lifetime energy savings is a strong measure of the value of energy efficiency because it represents the time over which the energy savings obtained in the first year will continue to deliver benefits. Longer lifetimes means customers save money over a longer period of time. Public Service also ranked high in peak demand reductions (eleventh) and energy efficiency programs diversity (thirteenth).

Q. PLEASE DESCRIBE THE PEER UTILITIES IN THE TOP 10 UTILITY PERFORMERS IN THE ACEE REPORT.

A. Beyond Xcel subsidiaries, the top 10 utility performers are primarily located on the east or west coast where energy costs are often higher. In addition, many of the utilities have a long history of delivering energy efficiency directly to their customers. No utility with a program entirely managed or delivered by a third party was included in the top performers. This reflects the importance of experience, continuity, and customer relationships to deliver strong DSM programs to customers. It further shows that Public Service is one of very few utilities in the central United States that has achieved such high performance.

Q. WHAT VALUE IS THE COMPANY BRINGING TO ITS ADMINISTRATION OF THE DSM PORTFOLIO?

A. The Company's administration of programs leverages four important efficiencies. First is context. The Company is able to recognize when a customer is at risk for a higher bill and help them find solutions to save energy in a much faster and less administratively burdensome fashion as handling this data as part of the normal course of business for the utility.

Second is data security. The Company is bound by strict requirements to protect customer data and minimize exposure to potential breaches; it is also subject to the Public Utilities Commission's ("the Commission") data privacy rules and general oversight. Adding non-regulated third parties to the administration of DSM programs creates data security concerns and potential customer data privacy issues.

Third, the Company provides for a more streamlined customer experience because a single point of contact can answer customer questions. Whether it is an account manager for an industrial customer or a residential customer care representative, a customer is more likely to achieve first call resolution when the number of redirections in order to find an answer is minimized.

Fourth, the Company acts as an administrator to ensure maximum cost-effectiveness of its DSM programs. Ultimately, no other party is directly accountable to customers for bill impacts other than Public Service. That provides Public Service with the unique position of having to balance the full costs and benefits to customers.

Q. WHAT EVIDENCE DOES THE COMPANY HAVE THAT CUSTOMERS VALUE THE ENERGY EFFICIENCY PROGRAMS IT DELIVERS?

The Company continuously monitors the factors that drive customer satisfaction related to energy supply and use. Market research shows that DSM aligns with two high priority customer demands: keeping energy costs low and giving them the opportunity to control their bills. More specifically, controlling energy bills is an area where customer demands are rapidly increasing. Nationwide trends show that awareness of DSM and billing options is increasing and, where customers are aware of programs, their engagement and satisfaction with energy providers is higher than those customers who are unaware of choices. Customers that actively opt in to DSM and other programs show even further satisfaction with the energy services they receive.

III. PUBLIC SERVICE'S 2016 POTENTIAL STUDY AND FUTURE FORECAST

Q. WHAT IS A POTENTIAL STUDY?

A. A "potential study" is a market analysis of current and future technologies, performed by an independent third party that examines how customers currently use energy, and how those energy end uses may be made more efficient in the future. Utilities and stakeholders use this tool to identify potential energy savings levels.

A potential study typically includes assumptions such as NTG, but does not take into account the delivery method or the policies associated with energy efficiency implementation. Instead, a potential study takes a higher-level view of the market to identify possible measures for inclusion in program design and implementation.

A potential study follows a three-stage screening process to remove measures that are not feasible for customers. The first is a technical screen that eliminates measures that will not physically work for a specific customer and end use.[5] The second is an economic screen that reduces the savings estimates to reflect measures that are not economically feasible for the customer or utility to implement when compared to other energy generation supply options. As explained below, the Company's most recent 2016 Potential Study used the

[5] End use is a DSM industry term for the final application of a DSM measure. For example, an air conditioner is a measure utilized by the consumer to cool air.

Modified Total Resource Cost ("MTRC")[6] cost-effectiveness test, consistent with Commission decisions. The third screen evaluates "achievable potential." This program screen evaluates past program effectiveness and technology adoption analyses to predict how other barriers, such as customer financial limitations, lack of customer knowledge, and customer preferences, will impact program participation.

Q. WHAT ROLE DOES THE ENERGY EFFICIENCY POTENTIAL STUDY PLAY IN THE COMPANY'S DSM PORTFOLIO?

A. Because it is prepared by an independent, third-party, the author of the Company's Potential Study does not have a vested interest in the outcome, the Potential Study is an unbiased, evidence-based estimate of the market potential for energy efficiency measures.

Historically, the potential study has been used as a foundational tool to determine appropriate energy efficiency goals for the Company. However, when considering study results, it is also important to consider the level at which savings are shown (i.e., net savings at the generator level) and the policy context in which the study was developed (i.e. a traditional focus on energy savings). These basic assumptions can influence the study outcome. As I discuss in

[6] The MTRC is a test to determine the cost-effectiveness of a DSM measure, product, or program by comparing the utility's administrative and rebate costs plus the customers implementation costs against the avoided costs to the utility in the form of future revenue requirements and customer rebate costs. Colorado statute defines cost-effectiveness of DSM at C.R.S. § 40-1-102(5)(a). In applying the statutory cost-effectiveness requirements, the Commission-approved standard for cost-effectiveness is encapsulated in the MTRC test, as commonly applied in the regulation of utility DSM. Decision No. C08-0560, at pp. 24-27, Decision No. C11-0442 at p. 7, footnote 7.

Section IV of my testimony below, the Company proposes to shift the policy context of energy efficiency in order to better align the value to customers.

Q. PLEASE SUMMARIZE THE RESULTS OF THE COMPANY'S MOST RECENT POTENTIAL STUDY.

A. As ordered in Decision No. C14-0731, Public Service conducted its most recent Potential Study in 2016 in advance of this Strategic Issues filing. The Company contracted with an experienced third-party consulting firm, Navigant Consulting, Inc., to conduct the study, which is contained in Attachment SMW-2. In addition to utilizing the three screening processes as described above, the Potential Study evaluates Public Service's technical, economic, and achievable potential results under four scenarios. Each scenario uses different variables, such as increased adoption rates of certain technologies, or increased rebates or incentives to forecast the potential energy savings within the Company's service territory. These four scenarios include the Reference case, Alternative Lighting, Max Benefits, and Low Benefits scenarios, as described below.

Reference Case: The Reference or Base Case starts with the Company's Colorado sales and customer long-term forecasts without factoring in the impact of existing DSM products. Navigant used this data, as well as other primary and secondary data from other sources, such as the Energy Information Administration ("EIA"), to project what new and existing housing and commercial building technologies should be modeled to estimate what potential exists for future energy and demand savings that could result if such technologies were adopted.

Alternative Lighting: The Alternative Lighting scenario reflects an accelerated introduction of LED lighting measures into the marketplace compared to the assumption made by Navigant in the Reference Case that CFL measures will retain a larger portion of the market during the beginning of the forecast period due to Navigant's CFL cost-effectiveness estimates.

Max Benefits: This scenario reflects increases in customer incentive spend that would optimize customer participation, which would then also maximize net benefits according to the Utility Cost Test ("UCT").

Low Benefits: The Low Benefits case is essentially the opposite of the Max Benefits case, i.e., this scenario assumes a minimum level of incentive spend to determine a portfolio that is minimally cost-effective under the UCT.

Q. DO THE ACHIEVABLE POTENTIAL SAVINGS REFLECTED IN THE SCENARIOS VARY OVER TIME?

A. Yes. Each scenario forecasts that the annual achievable potential savings from traditional electric energy efficiency products and programs in the Company's service territory vary over time, but are expected to decline between 2019 and 2028.

Q. HOW DO THE RESULTS OF THE 2016 POTENTIAL STUDY COMPARE TO PUBLIC SERVICE'S MOST RECENT COMMISSION-APPROVED GOALS AND PROPOSED GOALS?

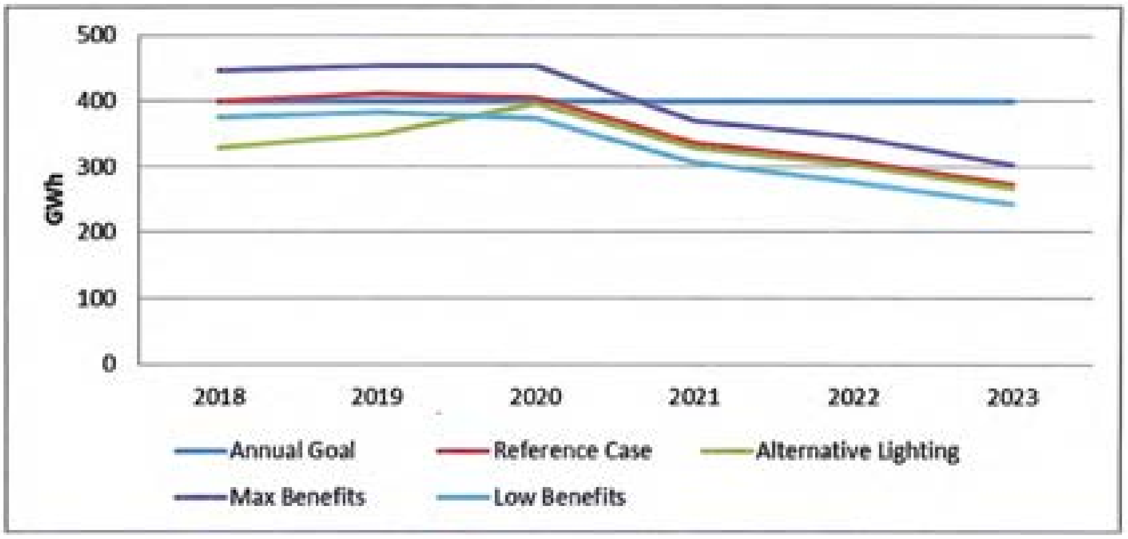
A. The table and chart below show the comparison of the achievable potential savings identified in the 2016 Potential Study against the 2018 goal approved in Proceeding No. 13A-686EG, and the Company's 2019-2023 proposed goals contained in this Strategic Issues filing:

Table SMW-D-1: Market Potential Assessment comparison to Proceeding No. 13A-0686EG Goals

		Achievable Potential			
YEAR	Annual GWh Goals[7]	Reference Case	Alternative Lighting	Max Benefits	Low Benefits
2018	400	399	328	447	374
2019	400	410	348	454	383
2020	400	405	395	453	374
2021	400	336	329	369	306
2022	400	308	302	345	277
2023	400	272	267	303	243

[7] As set in Proceeding No. 13A-0686EG.

Figure SMW-D-1: DSM Market Potential Assessment Study & Erosion of Energy Savings



As the above diagrams show, the goals established in Proceeding No. 13A-0686EG reflect a consistent level of achievement, whereas the Potential Study indicates a diminishing amount of energy savings in the future.

Q. WHAT TRENDS DO THESE UPDATED POTENTIAL ESTIMATES SUGGEST?

A. The estimates in the 2016 Potential Study suggest that the future potential from traditional energy efficiency is declining. This is due, in part, to increasing "organic" energy efficiency, which is the result of increasing codes, standards, and market conditions.

Q. WHAT ARE THE SOURCES OF VARIATION OVER THE 2019-2023 TIME PERIOD THAT MAY IMPACT THE COMPANY'S ABILITY TO ATTAIN ITS ENERGY SAVINGS GOALS?

A. Generally, newly enacted codes and standards will lead to increases in naturally-occurring adoption of energy efficient technologies outside of utility DSM products and programs. This, in turn, will lead to two results. First, it will reduce how often an energy efficiency technology is adopted because of a utility DSM product or program. Second, even if the energy efficiency technology is adopted through a utility DSM program, it will reduce the amount of energy savings attributable to the energy efficiency technology.

For example, the residential and business lighting markets have been affected by rapid technological advances in LED lighting. This has led to reductions in the cost of LED technology, which in turn, has driven greater adoption of LED technology, as evidenced by the success of the lighting measures in the Company's DSM portfolio. In 2016, lighting measures accounted for approximately 269 GWh of achievement, or 66% of the total portfolio achievement. LED technologies made up approximately 154 GWh of this achievement, or 38% of the total portfolio achievement. These levels of achievement are much higher than the 32 GWh of forecasted annual LED technology achievement identified in the prior 2009 DSM potential study that was updated in 2013. This level of achievement has been important in driving customers to realize energy savings opportunities. However, it is not sustainable.

As the lighting options in the marketplace increasingly move toward LEDs, the Company will need to focus efforts on specific customer segments that have not adopted LEDs. Simply put, a mass-market LED program has too much potential to give rebates to free riders while missing those customers who are not well served by the instant-markdown program format that has allowed such large achievements in prior years. Company witness Ms. Donna Beaman discusses changes to codes and standards, particularly with respect to lighting, in Section V of her direct testimony.

Q. WHAT ASSUMPTIONS DOES THE COMPANY'S 2016 POTENTIAL STUDY INCLUDE FOR RESIDENTIAL LIGHTING?

A. The Potential Study uses the following assumptions to evaluate the potential savings that can be achieved from Residential Lighting:

2018-2023: Energy savings for residential lighting measures appear to increase from 2018 to 2020, due to CFLs replacing the baseline incandescent bulbs before they become the baseline after 2020 due to anticipated changes to EISA standards at that time. After the standard change, the incremental potential from lighting is greatly reduced. Using these assumptions, the Potential Study estimates the Residential Lighting achievable potential savings from the Potential Study Reference Case shows the following:

Table SMW-D-2: Net Energy Savings potential for Residential Lighting – Reference Case

	LED (GWh)	CFL (GWh)	LED Specialty (GWh)	CFL Specialty (GWh)	TOTAL
2019	0	37.7	0.3	28.2	66.2
2020	0	5.9	0.3	16.1	22.3
2021	0	4.9	0.3	10.3	15.5
2022	0	3.8	0.3	6.9	11.0
2023	0	2.8	0.3	2.6	5.7

Q. HOW DOES THE ALTERNANTIVE LIGHTING SCENARIO ALTER THESE ASSUMPTIONS?

A. The Alternative Lighting Scenario estimates the achievable potential if LEDs are more established in the market than the assumptions were made in the Reference Case. The updated assessment estimated the Residential Lighting achievable potential savings from the Potential Study Alternative Case shows the following:

Table SMW-D-3: Net Energy Savings potential for Residential Lighting – Reference Case

Year	LED (GWh)	CFL (GWh)	LED Specialty (GWh)	CFL Specialty (GWh)	Total
2019	14.4	0.3	5.2	0.9	20.8
2020	4.0	0	4.0	0.7	8.7
2021	3.2	0	3.1	0.5	6.8
2022	2.6	0	2.5	0.4	5.5
2023	2.0	0	2.1	0.3	4.4

The Alternative Lighting scenario also confirms the incremental potential for Residential lighting savings is reduced over the planning horizon.

Q. DOES THE COMPANY BELIEVE THAT THE ALTERNATIVE LIGHTING SCENARIO BETTER REFLECTS WHAT IS ANTICIPATED IN THE LED LIGHTING MARKET FOR THE COMPANY'S SERVICE TERRITORY?

A. Yes. The Alternative Lighting scenario assumptions include some potential savings from CFLs early in the time period, but assume that the Company will make a responsible exit from the CFL market once the market is transformed. This approach is similar to the assumptions concerning CFLs that have been used in other states.

Q. HAVE EMERGING TECHNOLOGIES BEEN INCLUDED IN THE 2016 POTENTIAL STUDY?

A. No. According to the Potential Study:

> ...there is always the possibility that emerging technologies may arise that could increase savings opportunities over the forecast horizon, and broader societal changes may impact levels of energy use in ways not anticipated in the study. Due to the significant uncertainty associated with emerging technologies, this study reflects the best available view of what is currently available on the market and does not make assumptions about emerging technologies beyond capturing a range of potential uncertainty through scenario analysis (see Section 5.3). Similarly, this study does not make assumptions about future code and standard changes beyond those already planned for the study period.[8]

[8] See Attachment SMW-2, page 17.

Q. IS IT REASONABLE FOR THE POTENTIAL STUDY TO EXCLUDE EMERGING TECHNOLOGIES?

A. Yes, it is reasonable for a potential study to not factor in emerging technologies. A potential study relies on widely available assumptions about the type and amount of savings a measure can provide. These assumptions are generally not available or verifiable for emerging technologies. Therefore, it would be difficult to include these technologies and rely on them for the presumption of savings.

This reinforces why potential studies must be viewed as one tool of many in developing an energy efficiency portfolio. Nonetheless, the following section of my testimony I present the Company's proposed goals for energy efficiency as well as the implementation strategies to achieve those goals. As part of that, I identify emerging and existing technologies not considered in the 2016 Potential Study that the Company plans to pursue, along with our projected increase in forecasted energy savings.

IV. ADAPTING THE COMPANY'S DSM PORTFOLIO TO THE EVOLVING DSM LANDSCAPE

Q. PLEASE DISCUSS HOW THE EVOLVING NATURE OF ENERGY EFFICIENCY FITS INTO THE COMPANY'S DSM PORTFOLIO?

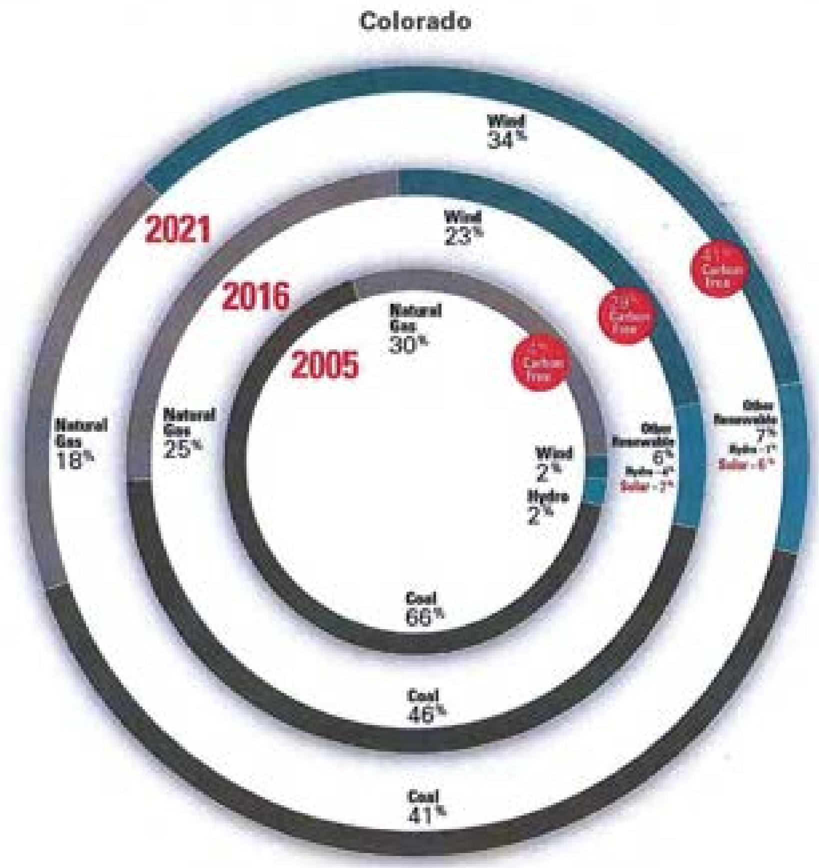
A. The Company's generation system has changed and continues to change to integrate increasing amounts of renewable energy. This change in the generation mix impacts energy efficiency, both economically (cost-effectiveness) and environmentally (emissions benefits). However, the Company is confident energy efficiency remains and will continue to be a valuable system resource when deployed correctly. The Company proposes incremental adjustments to the valuation and delivery of energy efficiency in order to unlock these value streams and provide better value to customers that the current energy efficiency policies allow.

A. Our Changing Generation System

Q. HOW HAS THE COMPANY'S SYSTEM CHANGED SINCE THE 2013 STRATEGIC ISSUES PROCEEDING?

A. Since that proceeding, Public Service's system has evolved to include an increasing amount of renewable and natural gas resources while decreasing the reliance on coal resources, as reflected in Figure SMW-D-2 below.

Figure SMW-D-2: Composition of Public Service Generation Fleet



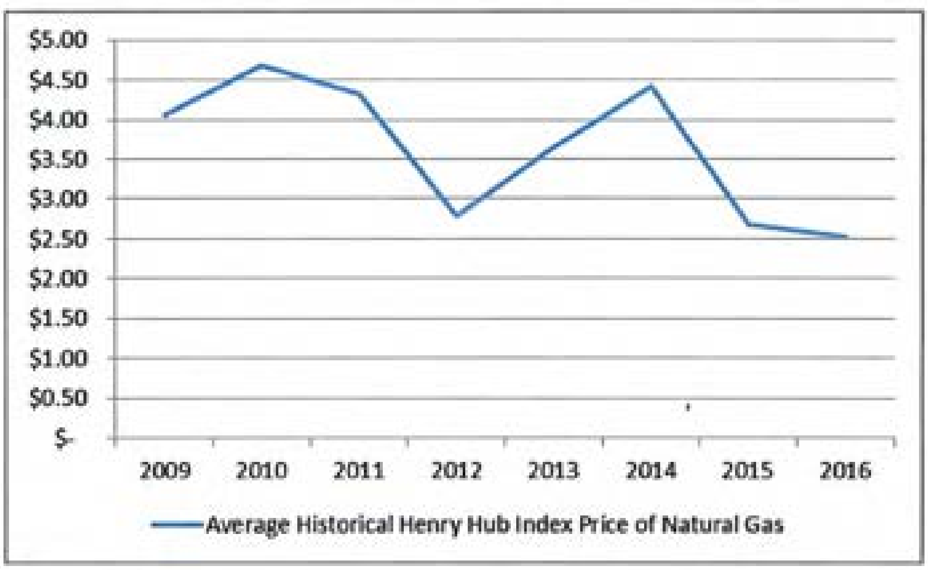
The Company expects this trend to continue or even accelerate in the future. First, the Commission has recently approved a substantial number of new wind projects to where the current system now consists of more than 2,500 MW of wind. This includes the recently approved Rush Creek proceeding (Proceeding No. 16A-0117E), which resulted in the addition of 600 MW of wind generation to the Company's portfolio.[9] Second, Phase II of the Company's Electric Resource

[9] In the 2013 All Source Solicitation the Company was approved to add 500 MW of wind. See Proceeding No. 11A-069E.

plan (Proceeding No. 16A-0396E) is currently underway and will result in the solicitation of new generation resources. The Company expects the Phase II process will result in additional renewable resources on Public Service's system. Regardless of the ongoing ERP, the Company expects the amount of coal generation in its portfolio to continue to decrease.[10]

Additionally, natural gas has increased as a percentage of electric generation on the Company's system. The price of natural gas has declined over time. As shown in Figure SMW-D-3 below:

Figure SMW-D-3: Average Historical Henry Hub Index of Natural Gas



Going forward, the Company's shift to a cleaner, more renewable-based fleet will create new challenges in utility system planning. One challenge we must

[10] See Section 1.6 of the 2016 ERP (Proceeding No. 16A-0396E), in which the Company stated: "All generation technologies with the exception of coal-fired generation would be deemed eligible technologies."

navigate is the continued erosion of avoided energy costs due to low fuel prices and zero fuel cost renewables. Another change is in system peaks through phenomena such as the "duck curve",[11] when variations in supply and net load are expected to cause a division in value between energy efficiency measures that are passive versus "smart" technologies that can react to electric grid conditions. It is prudent to adjust the Company's energy efficiency programs to address these challenges in system planning now, before the changes are fully ingrained in the system. Once these conditions are embedded in the system, the transition and adjustment will be more difficult and costly for customers, stakeholders, and the Company.

Q. HOW IS THE COMPANY'S PLAN FOR A CLEANER, GREENER FLEET IMPACTED BY THE CURRENT ENERGY SAVINGS GOALS?

A. The Company's strategy is not significantly impacted by its current energy savings goals. However, we anticipate some impacts that will be more pronounced in the future as additional renewable resources, especially wind, are added to the system.

The primary benefit of energy savings is to reduce the fuel costs customers must pay for. However, because the Company's recovery of renewable energy resource investments is spread out over a long period of time with no incremental fuel costs, the avoided energy cost moves closer to zero as

[11] "In certain times of the year, these curves produce a "belly" appearance in the mid-afternoon that quickly ramps up to produce an "arch" similar to the neck of a duck—hence the industry moniker of "The Duck Chart". *See*, https://www.caiso.com/Documents/FlexibleResourcesHelpRenewables_FastFacts.pdf

the amount of renewable energy on the system increases. At certain periods, this can result in the Company curtailing wind energy, which conflicts with the goal of a cleaner and greener fleet and stands to increase customers' energy bills. It may not benefit the system and customer to promote energy efficiency that produces savings during these high renewable production times.

Q. DOESN'T THE COMPANY ALWAYS HAVE BASELOAD, FOSSIL FUEL GENERATION RUNNING?

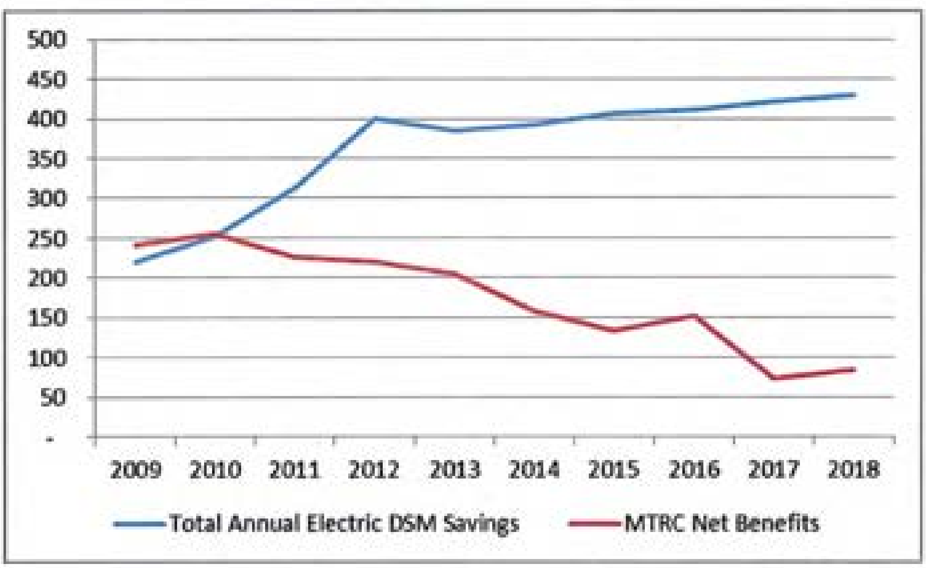
A. At this time the Company must always have fossil fuel generating units on line to ensure reliability and cost-effectively serve our customers. During periods of significant renewable generation, the Company minimizes fossil unit production to avoid curtailment of renewable generation. However, the Company does not shut down its fossil units for two reasons: renewable intermittency, and anticipated next day loads (shut down requires multiple hours to restart). Additionally, the Company is required by the Rocky Mountain Reserve Group ("RMRG") to carry Spinning Reserves in the form of curtailed fossil generation to respond to the sudden loss of generators in the group. However, in the event the Company must curtail wind resources, its base load fossil fuel generation has already been curtailed to the lowest possible level and additional DSM will not result in reducing this base load generation further. Thus, reducing energy consumption at these points will only result in further reductions in wind energy. Company witness Mr. David Horneck illustrates this effect further in his analysis of the marginal energy costs identified by the Company's PLEXOS® modelling software in Section III of his Direct Testimony.

B. The Effect and Opportunity of Generation Transformation on Energy Efficiency

Q. WHAT ARE THE EFFECTS OF THE CHANGES YOU MENTIONED ABOVE ON THE COMPANY'S DSM PROGRAMS?

A. The changes to the Company's generation portfolio have had a number of effects on the Company's DSM programs, most notably in the cost-effectiveness of energy efficiency. The chart below shows the historical MTRC Net Benefits from the Public Service energy efficiency portfolio.

Figure SMW-D-4: Comparison of Energy Savings (kWh) to MTRC Net Benefits ($mm)



As the chart shows, over time, net benefits have significantly decreased while achievements have mostly increased. This is the result of increasing amounts of less cost-effective energy efficiency being included in order to maintain ambitious energy savings targets, as well as the reduction in avoided costs.

Q. HOW DOES THE COMPANY FORESEE FACTORS SUCH AS CHANGING ENERGY COSTS AND SYSTEM PEAKS INFLUENCING ENERGY EFFICIENCY?

A. The erosion of avoided energy costs has the effect of reducing the benefits to energy efficiency. Historically, we have seen this impact through lower natural gas prices. As the cost for natural gas has declined, we have seen a corresponding decline in the fuel cost, which is a significant component of the avoided energy cost, as well as a shift away from coal generation to gas generation. Furthermore, a shift to wind and solar generation, which has no associated fuel cost, will continue to drive the downward pressure on avoided energy values.

Systems peaks are also likely to change. While Public Service's system is not experiencing issues like the "duck curve," increasing amounts of wind and solar will begin to shift when the system experiences peaking conditions. Increasing renewable penetration may shift those peaks to those periods when wind and solar are alternatively increasing or decreasing on the system. Energy efficiency that targets minimizing these peak impacts will be increasingly important just as addressing traditional, summer afternoon peaks is important today. This change will also encourage more dynamic signaling from the Company, which will require the tools and services to help customers understand these shifts, take actions to adjust to pricing and system need changes, and optimize customer business operations.

Energy efficiency is also moving away from the traditional, static concept of "install and forget" process to one that is more active. Services such as smart home systems or business optimization are becoming more prevalent as a result of increased customer engagement and new utility rate designs. With these changes will come a need for deeper education by the utility and continual involvement from the customer. Utilities must make sure their signaling and messaging are understandable so that customers take the right actions to reduce system impacts and customers must be continually engaged to ensure they are taking the right actions to control their energy costs. This is quite different from today when utilities have standard, inflexible rate designs and customers are primarily incentivized to install a measure, rather than optimize the value that new measure provides.

Q. HOW DOES THE ENERGY EFFICIENCY SAVINGS GOAL IMPACT SYSTEM PLANNING?

A. Energy efficiency, whether cost-effective or not, reduces the fuel consumption on the Company's system, which results in a lower energy requirement when conducting system planning. In addition, many energy efficiency measures include peak coincident demand reductions, which help reduce the need for peak capacity – often the most expensive type of capacity for the Company to acquire. However, not all measures have a significant peak coincidence. For example, LED street lighting has minimal peak impact because the measures are generally utilized off peak at night. Similarly, residential home lighting measures have a lower demand to energy savings ratio because much of the impact from home lighting measures occurs off peak at night. Alternatively, cooling measures such as residential and commercial heating, ventilation, and air conditioning have better demand to energy savings ratios because much of the savings occur during the peak period – i.e. summer weekdays from 2 – 6 p.m.

Q. HOW ARE CUSTOMERS AFFECTED BY THE DIVERGENCE OF ENERGY EFFICIENCY ACHIEVEMENTS AND NET BENEFITS?

A. This divergence of achievements and benefits had the unintended consequence of increasing volumetric rates.[12] This is because energy efficiency programs continue to reduce volumetric sales, while system benefits continue to decrease, thus creating upward pressure on volumetric rates. The end result is that while participating customers realize bill savings by reducing their energy usage, participants and non-participants alike see increased rates which offset some of the bill savings delivered by the programs.

Increasing rates is not consistent with the intent of Colorado's DSM statute. C.R.S. § 40-3.2-101 states, in part: "[C]ost-effective natural gas and electricity demand side management programs will save money for consumers and utilities and protect Colorado's environment." Today's energy efficiency

[12] Volumetric rates are those based upon the amount of energy (kWh) used and not on a fixed value (such as a service and facilities charge) or a demand value that is set monthly.

trajectory increasingly does not result in savings for customers and is less effective at protecting Colorado's environment through the reduction of emissions.

Q. HOW IS THE COMPANY PROPOSING TO ENSURE ENERGY EFFICIENCY PROGRAMS REMAIN VALUABLE TO CUSTOMERS AND THE COMPANY?

A. The Company proposes a new path forward for energy efficiency within a changing generation system. This path will focus on achieving energy savings where the marginal costs and emissions reductions are greatest. In order to do so, the Company will no longer value each kWh the same but instead will accurately value each kWh based upon the marginal type of avoided energy. To make this change, the Company is proposing to realign its energy and demand savings goals to provide more benefits to all customers.

C. How to Realign Energy Efficiency Programs to Maximize Benefits

Q. HOW CAN THE COMPANY EFFECT THIS CHANGE FROM AN OPERATIONAL PERSPECTIVE?

A. The Company can effect this change through a focus on peak demand reduction through energy efficiency, such as the adoption of load shifting measures that moves customer energy usage from high cost or constrained periods on the system to periods of lower cost and constraint. For example, ice storage[13] for cooling increases energy usage relative to traditional air conditioning systems by

[13] Ice storage is the process of using off-peak energy to freeze water that is melted during peak conditions to cool buildings, reducing a customer's usage on peak and over system load.

leveraging low-cost, low-emission off-peak energy to avoid higher-cost and higher emission resources more commonly associated with peak hours. The customer benefit from this is a reduction in peak demand charges that are often a significant factor in commercial and industrial customers' bills. The utility benefit from this action comes from a reduction in on-peak energy usage, which is often the most costly period. Overall, ice storage is one load shifting measure that stands to provide significant net benefits to customers because it is relatively low cost but delivers high savings at critical times.

Q. HOW DOES PUBLIC SERVICE MANAGE ITS CURRENT ENERGY EFFICIENCY PORTFOLIO?

A. The current portfolio is designed to: 1) cost-effectively achieve the annual energy savings goal of 400 GWh while also striving to meet the targets for energy efficiency demand reduction (65 MW); 2) maintain the Low-Income program spend; and, 3) remain within the Commission-approved budget cap of $85 million per year.

Historically, the Company has maintained a cost-effective energy efficiency portfolio while exceeding its goals and remaining under budget. Unfortunately, this has increasingly required the tradeoff of implementing less cost-effective (and sometimes non-cost-effective) energy efficiency products and measures in order to achieve all three targets. This is essentially the law of diminishing returns at work.

Q. HOW IS THE COMPANY PROPOSING TO REALIGN ITS ENERGY EFFICIENCY PORTFOLIO TO BETTER DRIVE VALUE IN THIS STRATEGIC ISSUES PROCEEDING?

A. The Company is proposing a number of changes to realign its delivery of energy efficiency and demand response programs to better reflect the current and future landscape for resource planning, renewable integration, and DSM.

First, the Company recommends that its energy efficiency goal be set to the following annual goals:

Table SMW-D-4: Proposed Annual Energy Savings (GWh) Goals

Year	2019	2020	2021	2022	2023	Total
GWh	350	350	325	325	325	1,675

Second, the Company recommends that its energy efficiency demand reduction goal, currently set at 65 MW per year, continue at the current levels to maintain focus on avoiding the most costly generation.

Table SMW-D-5: Proposed Annual Energy Efficiency Demand Reduction (MW) Goals

Year	2019	2020	2021	2022	2023	Total
MW	65	65	65	65	65	325

Q. PLEASE EXPLAIN THE COMPANY'S RECOMMENDED ENERGY EFFICIENCY GOALS IN GREATER DETAIL.

A. The proposed goals rely first upon the 2016 Potential Study to identify benchmarks for possible savings. The Company considered the "Alternative Lighting" scenario to be the most realistic reflection of the current energy efficiency marketplace in the Company's electric service territory as it did not consider potential savings associated with CFLs, which have been phased out of the Company's energy efficiency portfolio. Next, the Company applied its knowledge of the Colorado marketplace, such as increasing building codes in the Denver metro area, transformation of the mass market lighting market, and non-cost-effective measures to identify a goal of approximately 325 GWh per year in 2019 and 2020. The Company assumed that an additional 25 GWh should be added to the portfolio in order to account for emerging technologies and potential savings from measures such as ice storage.

In later years, the Company forecasts 325 GWh as an annual achievement to reflect changes in the areas such as the mass market lighting, residential heating and cooling, and commercial new construction markets not considered in the 2019 and 2020 goals. This assumption of declining savings is further reflected in the later years of the 2016 Potential Study where the Company's proposed goals actually exceed the 2016 Potential Study's forecast. Ms. Beaman discusses some of these factors in her Direct Testimony.

Q. DID THE COMPANY INCREASE ITS GOALS TO ACCOUNT FOR ITS HISTORIC GOAL ACHIEVEMENTS?

A. No. As I discuss later in my testimony, past achievements do not necessarily reflect future potential.

Q. WHAT ARE THE CONSEQUENCES OF SAVINGS GOALS THAT ARE SET INCORRECTLY?

A. When goals are too aggressive, the utility is placed in a position that, over the long run, will result in detrimental outcomes for customers. Either the Company can choose to add savings that have diminishing value or are not cost-effective, or it can achieve less savings than the goal and forego the DSM incentive. Examples of actions that would add savings, but are not in the customer interest include:

(1) Including less-cost-effective or non-cost-effective measures and products in the energy efficiency portfolio. These may provide energy savings, but diminish the overall benefits realized for all customers.

(2) Implementing programs on larger populations of customers that are incrementally not cost-effective, even when the program may still be cost effective overall. An example of this would be increasing the number of customers participating in the Energy Feedback product. There are diminishing returns to increasing the level of participation as each incremental customer is more likely to have reduced energy savings potential.

(3) Defining product baselines based on building codes or energy efficiency standards rather than the market baseline of equipment typically sold to customers in Colorado.

Q. SHOULD THE COMPANY'S ENERGY EFFICIENCY GOALS BE BINDING IN ORDER TO EVALUATE ACHIEVEMENT?

A. No. Binding goals remove the flexibility for the Company and stakeholders to prioritize the strategies and tactics in DSM Plans to drive the most benefit to customers. As we have seen with recent DSM Plans, the binding 400 GWh goal drives unintended consequences like the increase in less-cost-effective and non-cost-effective measures and products, and a focus on measures and products with limited persistence. Instead, non-binding goals should be identified to give the Company, stakeholders, and the Commission flexibility to optimize the implementation strategies periodically to reflect the most value for customers.

Furthermore, the Commission has historically approved non-binding goals, and the Company has nonetheless consistently achieved if not exceeded these non-binding goals. During the last DSM Strategic Issues proceeding, the Commission ordered the Company to achieve a non-binding goal, referred to as a target, of 65 MW of energy efficiency demand reduction. However, the Company's performance incentive and disincentive were not based upon achievement of this 65 MW and there was no punitive mechanism for the Company if it did not achieve this level of savings. Ultimately, the Company has consistently exceeded this level each year without a binding requirement or punitive action.

Q. HOW DOES COST-EFFECTIVENESS IMPROVE BY ACHIEVING LESS ENERGY SAVINGS?

A. As discussed above, achieving lower energy savings would mean removing non-cost-effective measures and products from the DSM portfolio and targeting energy efficiency savings to the times of highest values. This has the effect of increasing the net benefits through better evaluation and eliminating measures that reduce cost-effectiveness.

Q. HOW HAS MARKET TRANSFORMATION BEEN TAKEN INTO ACCOUNT BY THE COMPANY IN ITS PROPOSED ENERGY EFFICIENCY GOAL TO MAXIMIZE THE DELIVERY OF ENERGY EFFICIENCY?

A. As discussed in Section VII of the Direct Testimony of Company witness Mr. Brockett, the Company has a decades-long history of delivering energy efficiency programs. During this time, the Company has focused on not only achieving its goals but also transforming the marketplace to maximize the sustainability of energy efficiency and minimize the role of the utility where it is no longer needed.

The proposed goal reflects those learnings by recognizing that the marketplace, with the Company's help, has quickly evolved. This is especially pronounced in the mass market lighting sector where the transition from incandescent to CFL to LED has occurred quickly and now the Company is proposing to scale back its involvement in this area. As discussed in Section V of the Direct Testimony of Company witness Ms. Beaman discusses the lighting market has changed our programs and our delivery method for lighting will change in the future.

The new goal also reflects a stronger investment by the Company in areas where market transformation and support is still needed. As Ms. Beaman discusses further, the Company has helped transform the lighting market and is proposing to step back from much of this market.

Q. BASED ON THE CHANGES THE COMPANY IS PROPOSING IS IT FAIR TO SAY THE COMPANY IS REDUCING ITS GOAL?

A. Not significantly. As illustrated above, the Company is discussing the removal of hundreds of GWh of energy savings that are not cost-effective or are achieved in transformed markets. Yet, the Company proposes an energy savings goal that is only 50 GWh less than its current goal. This leaves a substantial gap for the Company to make up for by reinvesting in other areas and driving more cost-effective savings into the portfolio.

Q. CAN YOU DISCUSS IN MORE DETAIL SOME OF THE AREAS THE COMPANY IS REINVESTING IN ENERGY EFFICIENCY?

A. Yes. First, it is important to be clear that the Company is already investing in many of these areas. The reinvestment is only shifting funding from areas where the utility's impact is diminishing to areas where the utility's impact is more valuable.

Looking at the small business lighting sector, the Company plays an important role in coordinating a trade market to deliver solutions to these customers. Without the Company's implementation and coordination in this sector, it is unlikely that any market driven force would provide an adequate substitution. Small business customers typically require more direct attention and have lower capital budgets, which increases contractor administrative costs and reduces the potential margins for serving this sector. Without the assistance provided through its existing Small Business Lighting product, it is unlikely this class of customer would participate in energy efficiency.

Turning to the customer behavioral segment, there are existing products like the Residential Feedback product that fill this need; however, as residential rate designs advance and new technologies enter the market, it will be important to ensure customers are aware of and participating in these changes. For residential customers, this may mean educating on how to reduce peak demand and shift energy consumption.

In addition, as Ms. Beaman discusses in her Direct Testimony, there are significant efforts to be made in the midstream sector (e.g., distributors). In the field of energy efficiency, distribution is considered midstream because it falls between the manufacturer and the end use customer. Often, significant efforts are needed to ensure distributors actively stock high efficiency inventory. We believe there continues to be a role for the utility to transform this segment by encouraging distributors to maintain inventory of energy efficiency measures, and to provide education to and "upsell" residential and business customers on energy efficiency inventory when possible.

Q. WOULD AN ALTERNATIVE STRATEGY BE TO INCREASE THE COMPANY'S ENERGY EFFICIENCY BUDGET SO IT CAN DO MORE?

A. No. Increasing the energy efficiency budget to maintain unnecessarily high energy efficiency goals will only maintain or increase the level of non-cost-effective energy efficiency measures implemented through DSM plans. It is not a strategy that delivers the best value to customers. It also would have the effect of increasing customer costs and spending more customer funding than otherwise necessary to achieve optimal results.

Q. WHAT IS THE COMPANY PROPOSING AS A BUDGET FOR ENERGY EFFICIENCY?

A. The Company proposes a budget of $70 million per year with the flexibility to exceed the budget by 10% per year. This budget generally maintains the spending ratio present in previous Commission orders and provides a reasonable level of spending to achieve the Company's proposed energy efficiency goals. In addition, the flexibility to exceed the budget will allow the Company the ability to make strategic investments in new products and services or valuable platforms to deliver energy efficiency programs to customers. The Commission allowed for budget flexibility in the Company's operation of its energy efficiency programs from 2009 through 2013.

Q. WILL THE COMPANY'S ADVANCED GRID INTELLIGENCE AND SECURITY PROJECT IMPACT THE COMPANY'S REALIGNMENT OF ENERGY EFFICIENCY?

A. Yes. The advanced grid project will have an impact on how the Company delivers both energy efficiency and demand response programs by increasing the amount and granularity of data to the Company and customers. For example, the advanced grid will give the Company more insight into customer energy usage habits, which allow it to better tailor offerings, and targets customers with energy efficient products and services that maximize their participation benefit. This effort is also likely to offer positive benefits towards the Company's geo-targeting proposal discussed by Ms. Beaman.

Similarly, "smarter" pricing programs for demand response will be enabled. For example, Baltimore Gas and Electric Company offers a demand response program called "Smart Energy Rewards." The program is a behavioral-based demand response program that encourages customers to reduce peak demand by offering bill credits to customers.

The Company will propose appropriate products enabled by the advanced grid as part of future demand side management plans.

D. Better Aligning the Customer and Company Financial Compact

Q. WHAT DOES THE CURRENT ENERGY EFFICIENCY PERFORMANCE INCENTIVE MECHANISM ENCOURAGE THE COMPANY TO ACHIEVE?

A. The current mechanism authorizes the Company to earn five percent of net benefits upon achieving 100 percent of the Company's energy efficiency goal. This places the Company on a single-minded track to achieve energy savings at all costs. This creates a perverse incentive for the Company to implement non cost-effective measures and products to achieve its single energy savings goal to earn its incentive.

The existing incentive mechanism worked well when avoided costs were greater, renewable energy penetration was lower, and the system was growing at a level that minimized lost fixed costs. However, this reality has changed and it is reasonable the incentive mechanism also change.

Q. HOW DOES THE COMPANY'S PROPOSAL REFLECT A CHANGING SYSTEM AND BETTER INCENTIVIZE CUSTOMER VALUE?

A. As discussed in the Direct Testimony of Mr. Steve Wishart, the Company is proposing to implement a new energy efficiency Scorecard, which accounts for the changing system and better incentivize customer value. The energy efficiency Scorecard is a multi-metric performance incentive that reflects multiple mechanisms that drive customer value. The new metrics include:

(1) Energy Savings (kWh);

(2) Energy Efficiency Demand Reductions (kW);

(3) Low-Income Bill Reductions (participant net benefits);

(4) Utility Cost Test (ratio); and

(5) Lifetime Energy Savings (kWh).

The proposed Scorecard encourages the Company to balance its efforts across its portfolio and make investments where value can be maximized and the state and Commission policy goals can be best achieved. This incentivizes the Company to focus on maximizing net benefits from the energy efficiency portfolio. For example, if incremental energy savings are not cost-effective, the Company could forgo an incremental kWh in lieu of an incremental kW and still maintain earnings. Alternatively, if incremental energy and demand savings were unlikely to be cost-effective, the Company would have pathways to reduce costs in delivering low-income programs or reduce overall costs to energy efficiency programs and improve its Utility Cost Test results. Today, the Company does not have these pathways and is instead incentivized to include non-cost-effective energy efficiency in its portfolio, thereby reducing customer value.

Mr. Wishart discusses the mechanics of the Company's proposed DSM performance incentives in more detail.

Q. HOW WILL THE USE OF MARGINAL ENERGY-BASED AVOIDED COSTS IMPACT THE COMPANY'S ENERGY EFFICIENCY PERFORMANCE INCENTIVE?

A. The use of marginal energy costs will inform the Company's entire energy efficiency strategy as it identifies where the Company should target its efforts to achieve the maximum return for customers – that is, reducing energy and demand when it is most costly and reducing emissions when they are greatest. Under the current methodology of avoided energy costs, this is not the case as every kWh is effectively treated the same, meaning an avoided kWh of coal generation is treated the same as an avoided kWh of wind generation.

Furthermore, because the Company's proposed energy efficiency performance incentive is based on net benefits, the Company will have a direct financial incentive to focus on periods where it can maximize benefits.

V. AVOIDED EMISSIONS FROM ENERGY EFFICIENCY

Q. WHAT ROLE DO EMISSIONS AND THE AVOIDANCE OF EMISSIONS PLAY IN THE COMPANY'S ENERGY EFFICIENCY PORTFOLIO?

A. As discussed above, Colorado's DSM statute specifically recognizes the importance of using energy efficiency to protect the Colorado environment. Historically, that task was easy to accomplish when the generation system was heavily weighted toward coal-fired generation. However, increasingly the system is powered by wind generation and in the future will be even more renewable focused with wind and solar. Therefore, it is becoming more difficult to avoid emissions. As discussed earlier, this is part of the reason the Company is proposing a new strategy to deliver energy efficiency.

Q. PLEASE DEFINE THE AVOIDED EMISSIONS FROM ENERGY EFFICIENCY.

A. Avoided emissions from energy efficiency is the magnitude of emissions not produced at an electrical energy generation source associated with the reduced energy production necessary to serve customers due to customer participation in energy efficiency programs.

Q. HOW HAS EMISSIONS DATA BEEN USED IN THE PAST?

A. The primary use of the emissions data has been to provide estimates of the value of the avoided emissions ($/kWh) that could be applied in the MTRC as Avoided Emissions. In addition, the data has been used to estimate the emissions avoided – specifically CO2 (carbon) – by the DSM portfolio in previous DSM status reports.

Q. PLEASE DESCRIBE THE METHODS USED IN PAST FILINGS TO DETERMINE THE AVOIDED EMISSIONS FROM THE COMPANY'S ENERGY EFFICIENCY PROGRAMS.

A. The method used to determine the avoided emissions from energy efficiency has changed over time given the expected value of avoided emissions. In the DSM Plans covering the program years 2009-2011, an avoided emissions intensity ($/kWh) was determined for each future year by calculating the expected emissions with and without future DSM using the Strategist® software product. The difference in emissions and energy produced between these two runs each year was used to calculate the avoided emissions intensity for that year. These intensities were then applied to an assumed cost per pound ($/lb) for each emission to determine the $/kWh each year, which in turn were applied to each energy efficiency measure in the portfolio to determine the avoided emissions each year. In the DSM plans covering program years 2012-2018 the emissions intensity (lb/kWh) was based on the average emissions intensity of the electric generation portfolio as a whole. The assumed cost value for all avoided emissions was set to $0/lb.

Q. HOW IS THE COMPANY PROPOSING TO USE EMISSIONS DATA IN THE FUTURE?

A. In addition to using emissions in the MTRC test and estimating emissions from the DSM Portfolio, the Company proposes to use emissions data to determine the emissions avoidance of individual DSM measures. The Company is recommending that new DSM measures that may shift usage cost-effectively should be included in the DSM Portfolio. If these measures can be shown to meet the state objectives of being cost-effective and reducing emissions, the measures should be pursued through the DSM Portfolio. This is true even if the measure produces a net increase in energy usage.

Q. DOES THE FORM OF THE EMISSIONS DATA NEED TO CHANGE TO PERFORM AN ANALYSIS FOR EACH DSM MEASURE?

A. Yes. The Company's historical emissions data has been determined on a DSM Portfolio basis, but does not accurately determine the emissions of each individual measure. The methods did not consider the pattern of energy impacts throughout the year of the individual DSM measures. With the increasing diversity of generation sources described above, the timing of the energy savings has a significant effect on the amount of emissions avoided by a DSM measure. Analysis may show that measures that have a net increase in energy usage over a year may still result in emissions reductions. This may be the case if a measure produces a shifting of energy usage from high emissions hours (fossil-fuel generation) to low-emissions hours (renewable generation). To perform this analysis, it is necessary to have hourly marginal emissions data.

Q. HOW DOES THE COMPANY PROPOSE TO ESTIMATE HOURLY MARGINAL EMISSIONS?

A. The Company proposes a method that uses the hourly marginal energy price to determine the likely generation source of marginal energy each hour. An emissions rate for the generation source is then applied to this data to determine the marginal emissions rate (lb/MWh) for each hour.

Q. PLEASE EXPLAIN THE METHOD TO DETERMINE THE LIKELY GENERATION SOURCE AND ASSOCIATED EMISSIONS RATE FROM THE MARGINAL ENERGY PRICE.

A. The marginal energy price is a good indication of the marginal generation source, but it is not a perfect indicator. In most price ranges there is a mix of generation sources of marginal energy. Only at a few price levels is there a clear single source of generation of marginal energy. At other price ranges there is a mix of generation sources of marginal energy. The Company proposes that the method uses the system average emissions rate for the hour when there is a mix of generation sources of marginal energy.

Q. YOUR TESTIMONY ON EMISSIONS HAS BEEN LIMITED TO CO2 EMISSIONS. HAVE OTHER TYPES OF EMISSIONS BEEN CONSIDERED?

A. Yes, other emissions including sulfur dioxide (SO2) and mercury (Hg) have been considered. CO2 emissions are believed to serve as a fair proxy of those other emissions, especially considering the emergence of marginal energy from wind that produces no emissions, and that those other emissions have not been the main focus in the past. For these reasons, the proposed criteria that individual measures avoid emissions to be included in the portfolio should be based solely on the estimated avoided CO2 emissions.

Q. DOES THIS PROPOSED METHOD INCLUDE A VALUE OF AVOIDED EMISSIONS?

A. No. This proposed method only determines the rate of marginal emissions (lb/kWh) that can be applied to hourly energy savings or increases in hourly energy consumption. It does not include the value of avoided emissions ($/lbs). It does provide a more accurate measure of the emissions effect by individual DSM measure.

Q. DOES THE COMPANY BELIEVE THE PROPOSED METHOD IS SOUND AND REASONABLE?

A. Yes. The Company believes that the proposed methodology is sound and reasonably estimates the emissions avoidance from current and potential future DSM measures. As such, the Company believes this method is crucial in furthering the stated goal of achieving cost-effective emissions reductions.

Q. IS THE COMPANY PROPOSING AVOIDED EMISSIONS ESTIMATES BE APPROVED IN THIS FILING?

A. No. The Company is only asking for approval of a methodology to reasonably estimate the avoided emissions of individual DSM measures. This methodology would be applied in subsequent DSM Plan filings with the avoided emissions based on the data available at the time of the filing.

VI. DEMAND RESPONSE

Q. HOW DOES DEMAND RESPONSE FIT INTO THE COMPANY'S DSM PORTFOLIO?

A. As Company witness Mr. Brockett explains in Section VI of his Direct Testimony, DSM is composed of energy efficiency and demand response. Whereas energy efficiency is focused on reducing energy sales, demand response is focused on reducing peak demands. Both components of DSM provide significant value to customers and the utility, and the policies and goals for demand response are just as important to ensure a sustainable, cost-effective DSM portfolio in the future.

Q. IS THE COMPANY PROPOSING ANY CHANGES TO ITS DEMAND RESPONSE GOALS AND PROGRAMS FOR 2019 THROUGH 2023?

A. Yes, the Company proposes to realign the goals for 2019 through 2023 as follows:

Table SMW-D-6: Proposed Demand Response Goals

Year	2019	2020	2021	2022	2023
MW	465	476	489	503	520

Q. HOW DID THE COMPANY DEVELOP THESE GOALS?

A. The proposed goals are based upon historic achievements and trends in demand response growth as well as a reflection upon the state of the marketplace and the make-up of the Company's residential, commercial, and industrial offerings.

Company witness Mr. Brian Doyle discusses the state of the marketplace and the make-up of offerings in Section III of his Direct Testimony.

Q. HOW HAS THE COMPANY'S PAST PERFORMANCE COMPARED WITH ITS GOALS?

A. The 2013 Strategic Issues proceeding was the first which ordered the Company to achieve specific cumulative demand reduction goals.[14] The Company was ordered to achieve cumulative goals of 601 MW in 2015 and 606 MW in 2016. The Company's actual achievement for these years was 568 MW and 578 MW, respectively.

One reason for the shortfall in achievement is the Company's 2013 forecast included assumptions that one large industrial customer would begin participating in the interruptible service option credit ("ISOC") program in 2013 but subsequently decided not to participate in demand response.

Also, there has been a decline in the level of participation within existing programs. For example, Saver's Switch® – a residential demand response option – experiences approximately 7% attrition per year. Factors causing attrition include customers leaving from the program, disconnected switches, or non-responsive switches.

Additionally, there are limits to demand response such as market potential (the amount of customers already participating in demand response, technology constraints); the availability of cost-effective demand response programs; and customer satisfaction (the impact demand response has on the customers' business or lifestyle priorities). Mr. Doyle discusses these three limits further in his Direct Testimony.

Q. HOW DO THE GOALS COMPARE WITH THE LEVEL OF DEMAND REDUCTION ASSUMED FOR PURPOSES OF THE CURRENT ELECTRIC RESOURCE PLAN (PROCEEDING NO. 16A-0396E)?

A. The table below shows the level of cumulative demand reduction[15] (MW per year) the Company is proposing in this proceeding in comparison to the level of demand reduction assumed for purposes of the 2016 Electric Resource Plan.

Table SMW-D-8: Cumulative Demand Response Goal vs. 2011 Resource Plan

MW	2019	2020	2021	2022	2023
DR in 2016 ERP	598	623	623	623	623
Total Demand Reduction	530	541	554	568	585
Proposed Demand Response Goal	465	476	489	503	520
Energy Efficiency Demand Reduction Goal	65	65	65	65	65

Q. WHEN DOES THE COMPANY FORECAST ITS NEXT RESOURCE NEED?

A. Based upon the demand response assumptions included in the ERP, the next resource need is not until 2023. However, since the Company has achieved less than its forecasted goals, this need is somewhat greater than reflected in the ERP. Furthermore, just because the Company does not have an immediate need does not mean the Company should not invest in demand response programs.

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[14] The cumulative demand reduction goal was inclusive of the energy efficiency demand reduction achievement and the dispatchable demand response achievement.
[15] Total demand reduction includes the demand response goal and the energy efficiency demand reduction goal.

Q. WHY SHOULD THE COMPANY INVEST IN DEMAND RESPONSE IF THERE IS NO IMMEDIATE RESOURCE NEED?

A. Demand response, like generation supply investments, requires time to develop and deploy. Demand response requires customers to voluntarily agree to curtail their usage, which requires the Company to identify and recruit customers to participate. Prior to recruiting, the Company must design the financial and behavioral incentives to provide customers the reason to change their behavior by interrupting their comfort or business processes. None of these actions can be undertaken overnight and often require years to scale up. For example, the Company's ISOC and Saver's Switch® programs have grown to their current levels over the last decade of utility implementation.

Furthermore, the Company's system is changing for energy efficiency and this same change may offer increasing opportunities for demand response. It is in the best interest of customers and the Company to continue to investigate these new sources of value and provide products and services to meet these needs. Focusing solely on the need for peak capacity understates the value demand response may be able to provide.

Q. WHAT OPPORTUNITIES ARE THERE TO EXPAND THE SCOPE OF DEMAND RESPONSE ACHIEVEMENTS?

A. The Company's primary focus is on growing its existing offerings – primarily the smart thermostat offering to residential customers and the Peak Partner Rewards[16] program to commercial customers – but also expects new technologies and services to add additional scope to the future.

As home and workplace automation grows, the Company may also integrate strategies such as load shifting into its demand response portfolio to shift on peak consumption to shoulder and off peak periods as necessary. Load shifting allows for increased participant satisfaction (such as participant comfort or reduced operational interruptions) while gaining the benefit of reduced peak loads.

Q. IS THE COMPANY SEEKING APPROVAL TO IMPLEMENT ANY TECHNOLOGY OR SERVICE SPECIFIC PROGRAMS FOR DEMAND RESPONSE IN THIS PROCEEDING?

A. No. Any specific programs will be proposed in the Company's periodic DSM Plan filings.

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[16] The Peak Partner Rewards program is a demand response program for commercial and industrial customers to voluntarily reduce energy and peak demand during periods of system constraint in exchange for a financial incentive.

VII. DSM POLICY ISSUES

Q. WHAT DO YOU ADDRESS IN THIS SECTION OF TESTIMONY AND HOW DOES IT CONNECT TO THE COMPANY'S DSM PORTFOLIO?

A. In this section I will address policy questions regarding the claiming of savings in energy efficiency programs and a number of policies the Company agreed to identify and discuss in its 2017/2018 DSM Plan Settlement. Each of these policies has an effect on the implementation of DSM and the value provided to customers.

A. Secondary Site Savings

Q. WHAT ARE SECONDARY SITE SAVINGS?

A. Secondary site savings occur when an energy efficiency measure is installed with the intent to reduce electric usage but has a similar reduction to consumption from a secondary Company site such as a chilled water facility or steam heating facility.

Q. CAN YOU PROVIDE AN EXAMPLE OF HOW THIS CLAIMED SAVINGS PROCESS WORKS?

A. If a customer installs an energy-efficient variable frequency drive[17] ("VFD") at its primary location whose thermal energy source is the Company's chilled-water system, the Company currently only claims any energy efficiency savings achieved at that primary location. It does not claim any energy savings that may

[17] A variable-frequency drive ; is a device used to reduce the energy usage of a motor by varying the frequency and voltage to the motor.

have materialized at the chilled-water facility (secondary site) due to any reduced consumption at the primary site because of the installation of the energy efficient equipment. In this example, the Company is seeking approval to claim any energy and demand savings achieved from the installation of the VFD and the related energy savings at the chilled-water facility. By being able to identify and claim the savings from the chilled-water facility, the Company would also be able to determine and recognize the associated reduction in related emissions and savings in utility and customer costs.

Q. DOES THE COMPANY CURRENTLY CLAIM SECONDARY SITE SAVINGS?

A. No. Prior to 2015, the Company claimed secondary site savings as an indirect impact of energy efficiency actions. However, beginning in 2015, after conferring with the Commission Staff, the Company ceased claiming these savings.

The decision to stop claiming these savings stems from the interpretation of Commission Rule 4750, which states (emphasis added):

> These rules implement § § 40-1-102, 40-3.2-101, 40-3.2-103, and 40-3.2-105, C.R.S. for gas utilities required by statute to be rate-regulated. Consistent with statutory requirements, the purpose of these Demand Side Management (DSM) rules is **to reduce end-use natural gas consumption** in a cost effective manner, in order to save money for consumers and utilities, and protect the environment by encouraging the reduction of emissions and air pollutants.

Because the installed measures are reducing natural gas or electric consumption as the end-use consumption, this specific language could be read to imply secondary site savings should not be considered. However, when considering the rule and the referenced statutes in their entirety, the intent also includes the goal to "save money for consumers and utilities, and protect the environment by encouraging the reduction of emissions and air pollutants." The Company believes the latter interpretation is more consistent with the whole of the Colorado DSM statute and Commission rules.

Q. WHY IS THE COMPANY REQUESTING TO ACCOUNT FOR SECONDARY SITE SAVINGS?

A. Savings from secondary sites will result in saving money for consumers and utilities, and can help in the reduction of emissions by reducing the use of the fossil fuels used to supply chilled water cooling and steam heating.

Q. WHAT IS THE COMPANY'S SPECIFIC REQUEST REGARDING SECONDARY SITE SAVINGS?

A. The Company seeks clarification from the Commission that Rule 4750 does not preclude the Company from claiming secondary site savings in its energy, demand, and net benefit calculations.

B. Commercial and Industrial Behavioral Savings Methodology

Q. AS DISCUSSED IN MR. BROCKETT'S TESTIMONY, THE 2017/2018 DSM PLAN SETTLEMENT REQUIRES THE COMPANY TO PROPOSE AN ALTERNANTIVE METHODOLOGY FOR CLAIMING BEHAVIORAL SAVINGS. HOW HAS THE COMPANY COMPLIED WITH THIS REQUIREMENT?

A. The Company developed a new methodology to claim incremental electric and gas energy efficiency savings from business customers engaged in products with behavioral savings components and solicited input from the parties to the

2017/2018 DSM Plan.[18] The participating parties included the Southwest Energy Efficiency Project, the Energy Efficiency Business Coalition, Colorado Energy Consumers, Western Resource Advocates, the Office of Consumer Counsel, the Commission Staff, Energy Outreach Colorado, and the Colorado Energy Office.

Q. PLEASE EXPLAIN THE CURRENT METHODOLOGY USED BY THE COMPANY TO CLAIM BEHAVIORAL ENERGY EFFICIENCY SAVINGS.

A. The Company's current methodology for business behavioral savings is the "average savings method." To calculate annual energy savings, this method takes the observed savings, the difference between pre-treatment energy usage and post-treatment energy usage, and divides those over a time period (currently three years) for which the savings are evaluated. To calculate the lifetime energy savings, the methodology takes the annual claimed savings and multiplies those by the assumed lifetime of the behavioral actions. This results in annual energy savings each year of observation.

However, this methodology is flawed where energy savings are increasing over time. In this case, dividing the annual energy savings by the number of years of observation understates the total energy savings. It is likely that new behavioral actions at a site will be identified over time, resulting in increasing energy savings over time. This effect is detailed in Table SMW-D11 below.

[18] Proceeding No. 16A-0512EG.

Q. WHAT IS THE COMPANY'S PROPOSAL FOR AN ALTERNANTIVE METHODOLOGY?

A. The Company is proposing to use an "incremental savings method." Similar to the average savings method, this method calculates the difference between pre-treatment energy usage and post-treatment energy usage to determine the annual energy savings. However, in subsequent years, this methodology only calculates and claims the incremental growth in energy savings from behavioral actions. This method results in a sum of annual energy savings over time that match the annual energy savings recorded in the last year of observation.

Lifetime savings are calculated by multiplying the annual energy savings by the remaining useful life of the behavioral action. This process fairly discounts the annual energy savings for the presumed persistence of the action and reflects that savings occurring in later years are not as likely to persist as those generated in earlier years.

Q. CAN YOU PROVIDE AN ILLUSTRATIVE EXAMPLE OF THE AVERAGE SAVINGS VERSUS INCREMENTAL SAVINGS METHODS?

A. Yes, the following two tables provide an illustrative example of how savings would be claimed for a participant under both methodologies.

Table SMW-D-9: Average Savings Method

Average Savings Method	Year 1	Year 2	Year 3	**Cumulative Savings**
Observed Annual Energy Savings	500	700	800	**800**
Annual Energy Savings (1/3 of Observed)	167	233	267	**667**
Lifetime (yrs)	10	10	10	
kWh	1,667	2,333	2,667	**6,667**

Table SMW-D-10: Incremental Savings Method

Incremental Savings Method	Year 1	Year 2	Year 3	**Cumulative Savings**
Observed Annual Energy Savings	500	700	800	**800**
Annual Energy Savings (Minus Prev. Year)	500	200	100	**800**
Lifetime (yrs)	10	9	8	
kWh	5,000	1,800	800	**7,600**

As shown in the tables above, the average savings method results in a total of annual energy savings (667) that falls short of the final annual energy savings (800). The lifetime savings also are short of (6667) the actual lifetime savings (7600), which are accurately captured in the incremental savings method.

Q. WHY DOES THE COMPANY BELIEVE THE INCREMENTAL SAVINGS METHOD IS SUPERIOR TO THE AVERAGE SAVINGS METHOD?

A. The incremental method is a better method in the specific instance of measuring behavioral savings associated with individual participating business customers. This is because the Company can directly control the time period over which the savings will be observed for each customer.

However, the Company does not believe the incremental savings methodology is appropriate for mass market products such as the Energy Feedback product[19] because it is not possible to control for individual changes in participation due to customers moving from premises. This results in a variation in the participation time period, with some customers receiving the energy efficiency information for several years and some just beginning to receive the information. In this case, it is more appropriate to use the generalized method of average savings.

Q. IS THE COMPANY PROPOSING TO CHANGE THE RESIDENTIAL SAVINGS METHOD?

A. No. The Company recommends continuing to use the average savings method for the reasons described above. The incremental method would be impossible to implement administratively because it would require individually calculating savings for each participating customer, and the only other method currently

[19] The Energy Feedback product is the Company's residential behavioral product implemented as part of the 2015/2016 DSM Plan and reauthorized in the Company's 2017/2018 DSM Plan.

considered by the general industry is a deemed savings methodology. This methodology creates a prescriptive assumption that all customers save a specified amount. While this has the benefit of reducing measurement and verification ("M&V") and increasing the potential participation pool, it has the downside of being less verifiable and less likely to persist as incremental customers, with lower ability to save energy, begin participating in the product.

C. Reconsideration of the Avoided Transmission and Distribution Study

Q. AS DISCUSSED IN MR. BROCKETT'S TESTIMONY, THE 2017/2018 DSM PLAN SETTLEMENT REQUIRES THE COMPANY REEVALUATE ITS AVOIDED TRANSMISSION AND DISTRIBUTION COST STUDY. HOW HAS THE COMPANY COMPLIED WITH THIS REQUIREMENT?

A. In Proceeding No. 16A-0512EG the Company proposed a study to determine the avoided transmission and distribution cost value from implementing DSM programs.[20] This value assumes that system wide DSM would avoid system wide implementation costs. As part of the settlement agreement in that proceeding, the Company agreed to review its study and identify if using historical costs instead of forecasted costs would lead to more consistent and accurate accounting of avoided transmission and distribution costs.

[20] *See*, Attachment SMW-3.

Q. HOW DOES THE COMPANY ADDRESS THIS REQUIREMENT?

A. The Company has reviewed the study and its historic costs to identify if historic costs are applicable to the study's methodology and if so are more accurate than forecasted costs.

The Company conducted the study using the System Planning Method. The methodology is summarized in section 3.2.1.c on pages 75-76 of the U.S. Environmental Protection Agency's ("EPA") Assessing the Multiple Benefits of Clean Energy: A Resources for States (2010) report[21]. In alignment with the EPA study and the Company's 2017-2021 distribution forecast and budget process, the Company compared two scenarios; forecasted load reductions with DSM, and without DSM. The Company allocated the energy efficiency demand reduction goals of 65 MW per year to individual substation banks (or transformers) and feeders. The Company then compared the two scenarios and reviewed if load reductions deferred overloads into future years. Based on this analysis, the Company calculated that eight substation banks and thirty-five forecasted overloads were deferred to future years.

Q. HOW DID THE COMPANY CALCULATE THE DISTRIBUTION AVOIDED COSTS?

A. The Company developed a distribution cost probability table that was representative of different types of projects, the historical cost of each type of project, and the probability the Company would be required to mitigate a bank

[21] Source: http://www3.epa.gov/statelocalclimate/documents/pdf/epa_assessing_benefits_ch3.pdf#page=11

and feeder overload (referred to as the Distribution Cost Probability Table in the study). This information can be found in Appendix A1 of the study. The Company then calculated the savings for each of the 43 overloads that were deferred to future years based on the Distribution Cost Probability Table and the Company's weighted average cost of capital ("WACC") less the escalated expenditures for a given project due to inflation. Based on the calculated avoided Distribution costs the Company then increased the annual savings based on inflation as shown in Table 1 of the study.

Q. DOES THE COMPANY ANTICIPATE ANY CHANGES TO THE DISTRIUBTION PORTION OF THE STUDY?

A. No. The Company reviewed the study and determined it was already based on historical project costs and it was not dependent on future years' budget for capacity projects that could either decrease or increase dependent on the amount of available funding. As such, it is consistent with the intent of the settlement agreement and no changes were needed for the distribution portion of the study.

Q. DOES THE COMPANY BELIEVE ANY OTHER ADJUSTMENTS ARE NEEDED FOR THE DISTRIBUTION PORTION OF THE STUDY?

A. No. The system planning approach utilized by the Company was consistent with the Commission's Decision No. C15-0735.

Q. PLEASE PROVIDE A SUMMARY OF THE METHODOLOGY USED FOR AVOIDED TRANSMISSION COSTS.

A. A steady-state power flow contingency assessment was performed on the study cases using Siemens PTI PSSE software AC Contingency Calculation ("ACCC") function. The analysis included single (N-1) contingencies of the loss of transmission lines, transformers, and generating units in the Public Service (Area 70) and WAPA- Area 73 Balancing Authorities. Monitoring of transmission elements were reported for facilities experiencing a thermal overload based on its normal rating. Comparison of the "with future DSM" case (at the 65 MW goal level and for the higher sensitivity analysis level) to the "without future DSM" case determined whether a mitigation project could be deferred or avoided. If a mitigation project could be deferred, the estimated number of years of deferral were determined by identifying the time when the facility becomes overloaded in the "without future DSM" case versus when it becomes overloaded in the "with future DSM" cases. In the event that the "with future DSM" cases did not show an overload by 2026, the estimated overload was found by extrapolating the facility loading based on the loading growth in prior years.

Q. HOW DID THE COMPANY CALCULATE THE TRANSMISSION AVOIDED COSTS?

A. The resulting cost savings were calculated using a planning estimate of a potential mitigation project for the particular transmission issue. The cost savings calculation assumed the Company's WACC, as well as the current assumed weighted corporate escalation factor of 2.00%.

Q. BASED ON THE SETTLEMENT AGREEMENT, DOES THE COMPANY ANTICIPATE ANY CHANGES TO THE TRANSMISSION PORTION OF THE STUDY?

A. No. Proposed transmission projects are typically large-scale, multi-year undertakings that undergo years of pre-development work before becoming planned projects. Over the past six-year period, only a single load-driven project has been constructed in Colorado by the Company (the Rifle-Parachute 230kV Line #2). The project was placed in service in 2016 and was driven by oil and gas load development

VIII. <u>CONCLUSION</u>

Q. DOES THIS CONCLUDE YOUR TESTIMONY?

A. Yes, it does.

Statement of Qualifications

Shawn M. White

I graduated from Hawaii Pacific University with a Bachelor of Science in Marketing and the University of Minnesota's Carlson School of Business with a Master's degree in Strategic Management. I am also a graduate of the United States Navy's Nuclear Power Program.

I am the Manager of the DSM and Renewable Regulatory Strategy and Planning Group at Xcel Energy. I manage a group whose primary responsibilities are to: (i) ensure that Xcel Energy's energy efficiency and demand response programs are adhering to regulatory policies; (ii) develop long-range goals for the portfolio of programs for resource planning; (iii) track and report on energy efficiency achievements and financial operations; (iv) prepare DSM regulatory reports and filings; and (v) analyze the cost-effectiveness of energy efficiency and load management programs and portfolios in each of Xcel Energy's state jurisdictions with active energy efficiency programs or pending legislation. I am also responsible for setting measurement and verification (M&V) policies and ensuring that proper M&V is being conducted for all programs.

I have held several positions within Xcel Energy's DSM group, including Marketing Assistant, Program Manager, and Manager of Consumer and Commercial Energy Efficiency Marketing. I have been responsible for the oversight of energy efficiency and load management programs in New Mexico, Texas, Minnesota, and

Colorado. I also have nine years of experience in the operation and maintenance of nuclear power plants.

NAVIGANT

2016 Demand-Side Management Potential Study

Prepared for:

Public Service Company of Colorado

d/b/a Xcel Energy

Xcel Energy®

FINAL REPORT

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EXECUTIVE SUMMARY

This executive summary provides a high-level overview of the work performed and the findings of the Xcel Energy Demand-Side Management (DSM) Potential Study developed by Navigant (Potential Study). More detailed discussions and results are included in the main body of the report.

Introduction and Background

Navigant was retained by Xcel Energy to develop an estimate of the potential for energy efficiency for the company's Colorado service territory over an 11-year time horizon from 2018 to 2028. Navigant has worked with Xcel Energy to develop information on current levels and patterns of energy use in Colorado, characterize potential measures which could be implemented to increase energy efficiency within demand-side management (DSM) in the service territory, and develop an estimate of DSM potential. This study focused on energy efficiency within DSM and did not address demand response potential.[1] The technical, economic and achievable potential for energy efficiency within DSM was modeled using Navigant's proprietary DSMSim™ model.

The study data and analysis will assist Xcel Energy in informing its proposal of economically achievable goals in the next DSM Strategic Issues proceeding and in informing its development of future DSM Plans. Throughout this study, Navigant sought regular input and feedback from both internal and external stakeholders, who provided important market knowledge and industry expertise for producing a robust final study.

Approach

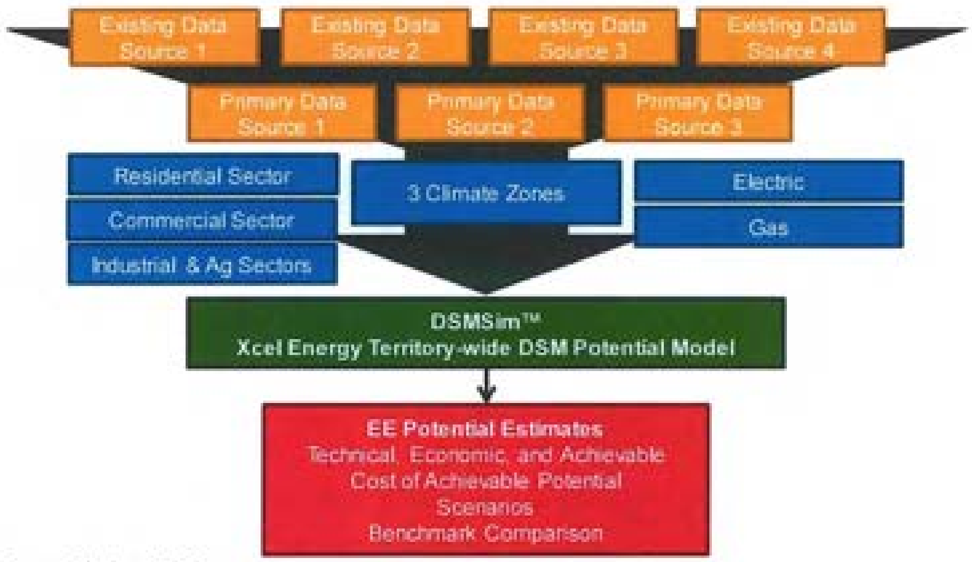
This section describes the overall approach to the Potential Study, including the approach to base case forecast, measure identification and characterization, and estimating technical, economic and achievable potential. The overall approach to the Potential Study is illustrated in Figure 1. In general, the Potential Study begins with a detailed assessment of data sources that are specific to Xcel Energy's Colorado service territory. Those sources then are supplemented with primary field data collection complemented by secondary sources. The specific sectors (residential, commercial and industrial/ag) and the various segments within those sectors are assessed, differences in the three climate zones[2] within the service territory are assessed from a DSM measure perspective, and impacts are reviewed for both electric and gas measures as well as measures that result in savings for both fuels. All of this information is imported into the DSMSim™ model and territory-wide estimates of DSM potential are generated.

As agreed upon with Xcel Energy, the results presented in this study are *net*, rather than *gross* savings, with net-to-gross (NTG) factors applied to measure savings to account for free ridership and spillover at the measure level.

[1] Navigant did include the energy savings from Xcel Energy's Saver's Switch measure, but excluded the demand savings, since these are addressed in a separate study on demand response potential.

[2] Climate zones as defined by the International Energy Conservation Code Climate Regions. See http://www1.eere.energy.gov/buildings/publications/pdfs/building_america/4_3a_ba_innov_buildingscienceclimatemaps_011713.pdf. Zone 5 includes the Front Range (Denver, Boulder, Colorado Springs), eastern plains, and central western Colorado; Climate Zone 6 includes central southern Colorado and north-west Colorado; while Climate Zone 7 includes the central mountains.

Figure 1. Project Approach



Source: Navigant 2016.

Data Sources

For this project, Xcel Energy tasked Navigant with developing an enhanced data collection process that included a review of existing secondary data and primary data collection process to supplement those secondary sources. Navigant used Colorado-specific data provided by Xcel Energy wherever possible, supplementing that data with information available from neighboring and comparable jurisdictions and other sources such as the U.S. Energy Information Administration (EIA). This approach resulted in the use of primary data collection to supplement the available secondary data as required.

Table 1lists some of the data required and the type of data Navigant used in characterizing the measures. In the table, existing Colorado data refers to data provided to Navigant by Xcel Energy, primary data refers to information that was collected through customer surveys, and secondary non-Colorado data refers to utility studies, previous baselines and potential studies in neighboring jurisdictions and other sources (as discussed above).

Table 1. Characterization Data Required

Data Required for Measure & Market Characterization	Existing Xcel Energy Data Sources	Primary Data Collection	Secondary Data Sources
For Base and DSM Measures			
• Measure lifetime	✓		✓
• Measure Costs	✓		✓
• Energy Consumption (gas or electric)	✓		✓
• Coincident Peak Demand (electric only)	✓		✓
O&M Savings (if applicable)			✓
Measure Density (Base + DSM measures)	✓	✓	✓
Technical Suitability (Ability to implement DSM measure)	✓	✓	✓
Initial Saturation of End-Uses	✓	✓	✓
Customer Acceptance of DSM Measures	✓	✓	✓

Source: Navigant 2016.

For the primary data collection efforts, Navigant used a combination of online, telephone and onsite surveys of end-use customers regarding electricity and natural gas markets in Colorado. Subcontractor Tetra Tech conducted the online and telephone surveys. Navigant's field staff conducted the onsite surveys. The survey process was employed to obtain primary information about equipment stocks, efficiency levels and decision-making processes. Surveys were set up to collect this information from up to 1,500 residential customers and 350 commercial and industrial/ag customers. The goal of this effort was to achieve confidence levels of 90 percent with a +/- 10 percent margin of error for each sector. The process was designed to obtain the highest possible level of confidence across these three sectors and the various segments within each sector. The onsite surveys were carried out using a nested sampling approach whereby a subset of valid responses from the online and telephone surveys were randomly selected for onsite visits. A total of 97 onsite surveys were completed for the residential sector and 50 for the commercial and industrial/ag sectors.

Another telephone survey effort was initiated for upstream market actors (including implementers, distributors, contractors, retailers and manufacturers) to better understand and validate the customer's responses to equipment replacement practices and customer willingness to invest in DSM measures and programs. Navigant's survey staff conducted the upstream market actor surveys. A total of 26 upstream market actor surveys were completed and those results were incorporated into the study.

Base Case Forecast

Navigant obtained forecasts of electricity and natural gas demand from Xcel Energy. Navigant developed projections of residential building stocks and commercial floor area for the Potential Study period. The potential for DSM was then modeled based on the resulting stocks and the changing proportion of new and existing buildings. Navigant did not develop an independent forecast of electricity and natural gas energy requirements.

Measure Identification and Characterization

Navigant developed a comprehensive measure list of energy efficiency measures likely to contribute to economic potential. The team reviewed current Xcel Energy program offerings, previous Xcel Energy potential studies, and potential model measure lists from other jurisdictions to identify DSM measures with the highest expected economic impact. The team supplemented the measure list using potential studies from British Columbia, Oregon, Arkansas, Pennsylvania, and Illinois, as well as technical resource manuals (TRMs).

The review process resulted in a list of 178 energy efficiency measures, which were analyzed in detail and ultimately incorporated into the Potential Study. These measures were then characterized for each segment where they could be applied. Weather sensitive measures were also characterized for each climate zone in Xcel Energy's Colorado service territory.

Estimation of Potentials

For this resource assessment, Navigant employed its proprietary DSMSim™ potential model to estimate the technical, economic, and achievable potential for electric and gas savings. DSMSim™ is a bottom-up technology diffusion and stock tracking model implemented using a System Dynamics[3] framework. The DSMSim™ model explicitly accounts for considerations impacting retrofit, replace-on-burnout and new construction measures. For each of the replacement types, technical, economic, and achievable potential was determined and is reported in aggregate by sector, customer segment and end use.

Xcel Energy has some customers to which it provides both gas and electric service, some to which it provides electric only service, and some to which it provides gas only service. Potential estimates do not include "ancillary" savings to non-Xcel Energy utilities, such as reductions in electricity use that result indirectly from an Xcel Energy gas utility program or vice versa. To best capture the variable savings that some measures will have across these different types of customers, Navigant characterized measures that have both gas and electric savings (e.g., programmable thermostats, insulation, home energy reports, etc.) differently depending on the utility service type and heating fuel characteristics of the customer. This allowed both gas and electric savings potential, cost effectiveness, and incentives to be captured without the risk of double counting.

Technical potential is defined as the energy savings that can be achieved assuming that all installed measures can immediately be replaced with the efficient measure, wherever technically feasible, regardless of the cost, market acceptance, or whether a measure has failed (or "burned out") and is in need of being replaced. Economic potential is a subset of technical potential, using the same assumptions regarding immediate replacement as in technical potential, but limiting the calculation only to those measures that have passed the benefit-cost test chosen for measure screening, which in this case is the modified Total Resource Cost (mTRC) test. Achievable potential is a subset of economic potential, but further considers the likely rate of DSM acquisition, which is driven by a number of factors including the rate of equipment turnover (a function of measure's lifetime), simulated incentive levels, budget constraints, consumer willingness to adopt efficient technologies, and the likely rate at which marketing activities can facilitate technology adoption.

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[3] See Sterman, John D. *Business Dynamics: Systems Thinking and Modeling for a Complex World*. Irwin McGraw-Hill. 2000 for detail on System Dynamics modelling. Also see http://web.mit.edu/sysdyn/sd-intro/ for a high-level overview.

Navigant also conducted scenario analyses as part of this Potential Study, modeling the sensitivity of the achievable potential to different scenarios. Navigant modeled the impact of three scenarios (Max Utility Benefits, Low Utility Benefits, and Alternative Lighting) relative to the base case.

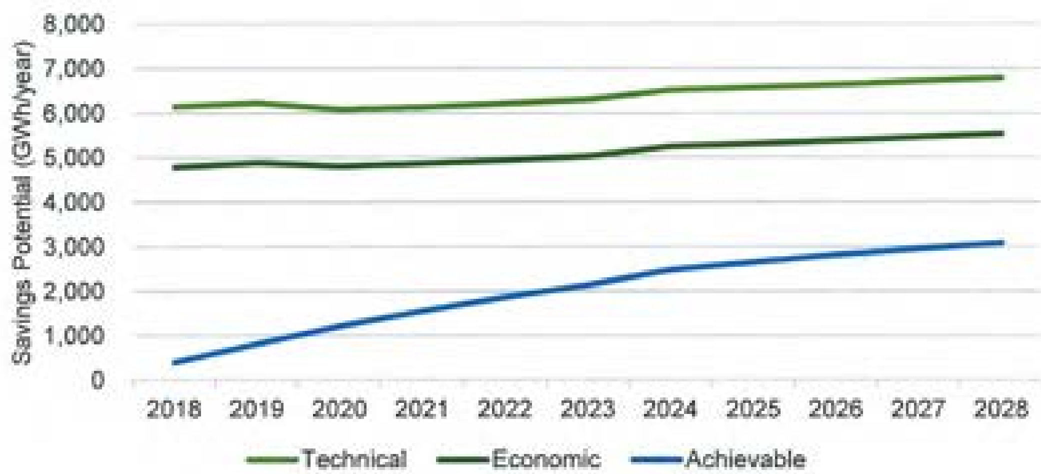
Findings

Summary of Potentials

Using the DSMSim™ model, Navigant found that 6,786 GWh of electricity and 29 million Decatherms of natural gas technical potential in the Xcel Energy service territory by 2028, as shown in Figure 2 and Table 2 for electric potential and Figure 3 and Table 3 for gas potential. Roughly 82 percent of the electric technical potential and 55 percent of the gas technical potential was found to be economic, meaning that it met or exceeded an mTRC ratio of 1.0 for all DSM measures covering the residential, commercial and industrial/ag sectors. Electric economic potential in 2028 is projected to be 5,531 GWh while gas economic potential in 2028 is projected to be 16 million Decatherms. Technical and economic potential are relatively flat over the time horizon, with growth driven by increases in forecast building stock and electricity consumption.

The achievable potential shown below (and in most figures throughout this report, except where budget scenarios are presented) is for the "Reference" scenario. Since achievable potential factors in the rate of DSM acquisition (technical and economic potential do not), forecast achievable potential grows over the 11-year forecast horizon, reaching 3,073 GWh of electricity savings and 7.6 million Decatherms of natural gas savings by 2028.[4]

Figure 2. Cumulative Electric EE Potential (GWh/year)



Source: Navigant analysis, 2016

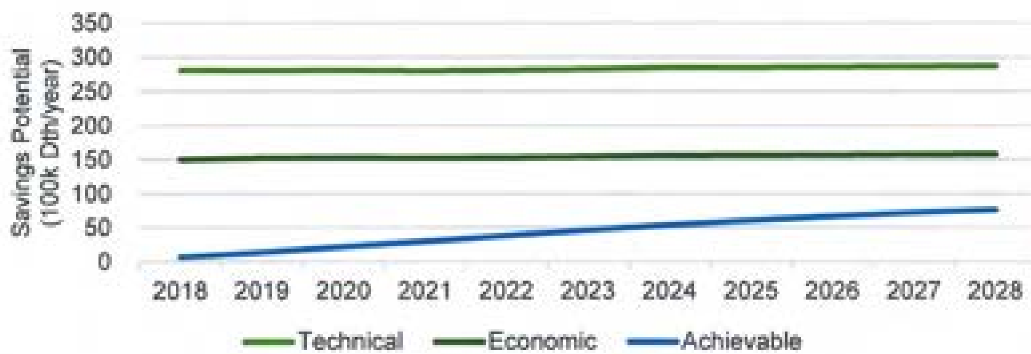
[4] Note that the achievable savings reported in Figure 2 represent cumulative savings over the forecast horizon, which is the cumulative sum of each year's incremental savings. There are other instances in this report where incremental achievable savings are reported. When achievable savings are reported, there will be a clear indication as to whether those savings are cumulative or incremental.

Table 2. Cumulative Electric EE Potential (GWh/year)

Year	Technical	Economic	Achievable
2018	6,142	4,778	399
2019	6,222	4,878	810
2020	6,077	4,804	1,215
2021	6,132	4,862	1,551
2022	6,203	4,935	1,859
2023	6,289	5,022	2,131
2024	6,508	5,245	2,470
2025	6,566	5,306	2,648
2026	6,634	5,375	2,805
2027	6,709	5,452	2,945
2028	6,786	5,531	3,073

Source: Navigant analysis, 2016

Figure 3. Cumulative Gas EE Potential (100K DTh/year)



Source: Navigant analysis, 2016

Table 3. Cumulative Gas EE Potential (100k Dth/year)

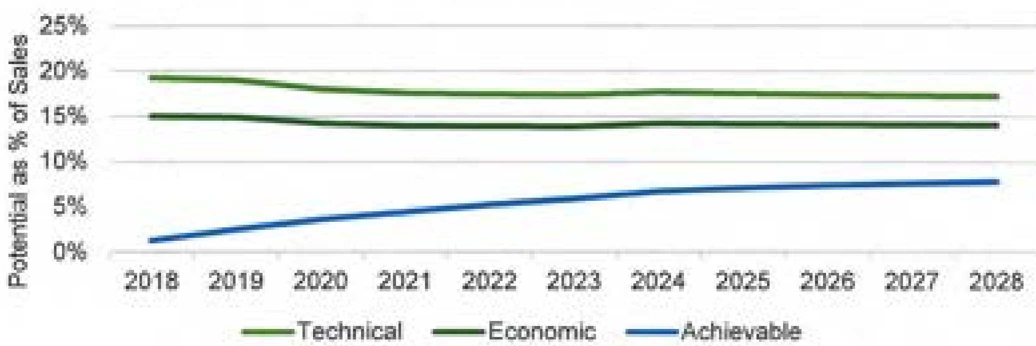
Year	Technical	Economic	Achievable
2018	281	150	6
2019	281	153	14
2020	281	153	22
2021	280	153	29
2022	281	153	38
2023	283	154	46
2024	285	156	54
2025	285	156	60
2026	286	157	66
2027	287	158	71
2028	288	159	76

Source: Navigant analysis, 2016

Potential as a Percentage of Sales

Figure 4 and Table 4 shows technical, economic, and achievable potential as a percentage of forecast electric sales. Cumulative electric achievable potential, which accounts for the rate of DSM acquisition, grows to nearly 8 percent of forecast electric sales in 2028, or 0.8 percent per year on average over the 11-year study horizon, under the Reference achievable potential scenario. For gas, the cumulative achievable potential grows to 5 percent of forecast gas sales in 2028, or 0.5 percent per year on average over the 11-year study horizon.[5] This degree of achievable potential is consistent with Navigant's observations of savings levels in other jurisdictions it has studied, providing a degree of confidence that the results are reasonable. As is shown later in the report, higher savings are ultimately achievable with higher budget assumptions.

Figure 4. Cumulative Electric Potential as a Percent of Electric Sales



Source: Navigant analysis, 2016

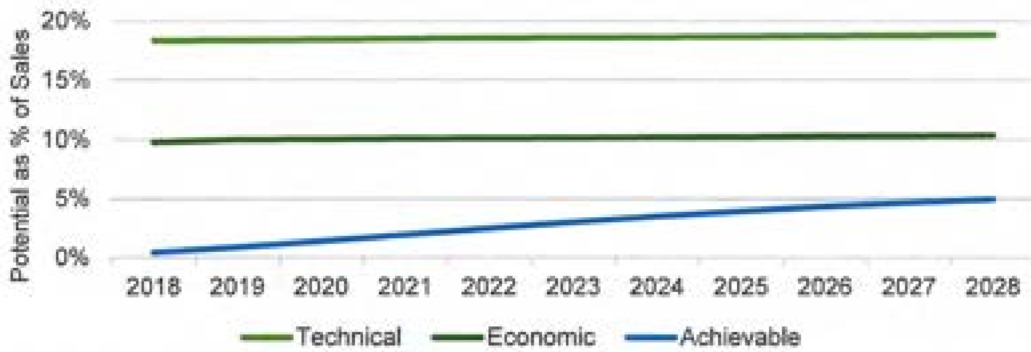
Table 4. Cumulative Electric Potential as a Percent of Electric Sales

Year	Technical	Economic	Achievable
2018	19.3%	15.0%	1.3%
2019	19.0%	14.9%	2.5%
2020	18.0%	14.2%	3.6%
2021	17.6%	13.9%	4.4%
2022	17.4%	13.9%	5.2%
2023	17.4%	13.9%	5.9%
2024	17.7%	14.2%	6.7%
2025	17.5%	14.2%	7.1%
2026	17.4%	14.1%	7.4%
2027	17.3%	14.1%	7.6%
2028	17.2%	14.0%	7.8%

Source: Navigant analysis, 2016

[5] These results are for gas sales to all DSM-eligible customers, which excludes transport customers who are not eligible to participate in DSM within Xcel Energy's territory.

Figure 5. Cumulative Gas Potential as a Percent of Gas Sales



Source: Navigant analysis, 2016

Table 5. Cumulative Gas Potential as a Percent of Gas Sales

Year	Technical	Economic	Achievable
2018	18.3%	9.8%	0.4%
2019	18.4%	10.0%	0.9%
2020	18.4%	10.0%	1.4%
2021	18.5%	10.1%	1.9%
2022	18.5%	10.1%	2.5%
2023	18.6%	10.2%	3.0%
2024	18.6%	10.2%	3.5%
2025	18.7%	10.2%	4.0%
2026	18.7%	10.3%	4.3%
2027	18.8%	10.3%	4.7%
2028	18.8%	10.4%	5.0%

Source: Navigant analysis, 2016

Achievable Potential Funding

Navigant developed estimates of DSM program funding needed to support the various levels of achievable potential to be obtained during the study period. Table 6 presents the estimated funding levels for select years of the forecast under the Reference Scenario. The incentive budgets were simulated through the DSMSim™ model based on the measures that make up the achievable potential estimates. Incentive values change over time due changes in the mix of DSM measures, cost inflation, and market saturation. The administration budgets are based on historical expenditures for administration reported by the utilities. As a conservative estimate, administration values were held constant over time.

Table 6. Estimated Annual EE Program Funding, Reference Scenario

Year	Electric			Gas			Total Funding
	Incentive	Administration	Total	Incentive	Administration	Total	
2018	35.05	46.81	81.86	10.86	5.62	16.48	98.34
2019	38.90	46.81	85.71	11.90	5.62	17.52	103.23
2020	44.23	46.81	91.04	13.04	5.62	18.66	109.70
2025	40.05	46.81	86.85	11.79	5.62	17.41	104.26
2028	27.76	46.81	74.56	9.35	5.62	14.97	89.54

Source: Navigant analysis, 2016

As can be seen from the table, the total simulated funding that corresponds with the Reference Scenario for achievable potential is through the DSMSim™ model $98 million in 2018 and just under $90 million by 2028. Nearly 85 percent of the funding is attributable to electric DSM program efforts.

Achievable Potential Scenarios

In addition to modelling the base case scenario, Navigant also modelled achievable potential and costs for three alternative scenarios – Max Utility Benefits, Low Utility Benefits and Alternative Lighting. Increasing adoption of efficient technologies can be accomplished in a number of different ways. Often, potential studies simply increase the assumed level of incentives or participation. Since Xcel was interested in viewing energy efficiency savings as a resource, Navigant explored varying incentives through measure targeted payback periods to find optimal levels that would maximize utility net benefits in the Utility Cost Test. This is the Max Utility Benefits scenario. The Low Utility Benefits scenario moves the targeted payback a similar magnitude, but in the opposite direction. Finally, because Xcel was interested in moving away from incenting CFL adoption in light of changing market conditions, in the Alternative Lighting scenario, Navigant modeled the effect of large barriers to CFL uptake, such as market availability, holding budgets constant. The resulting scenario shows a much higher uptake of LEDs, but lower levels of portfolio savings due to the higher relative costs of these measures.

Table 7 shows the electric achievable potential, the percent reduction, and the annual budget in 2018 and 2028 for the three alternative scenarios analyzed in this Potential Study.
Table 8 shows the comparable information (only Max Utility Benefits and Low Utility Benefits) for the gas achievable potential.

Table 7. Electric Achievable Potential and Budget by Scenario

Year	Cumulative Savings (GWh)	Percent of Sales	Annual Budget (Million $)
Max Utility Benefits Scenario			
2018	447	1.4%	$116.9
2019	901	2.8%	$119.9
2020	1,354	4.0%	$127.9
2025	2,923	7.8%	$103.4
2028	3,380	8.6%	$91.8
Low Utility Benefits Scenario			
2018	374	1.2%	$63.7
2019	758	2.3%	$65.5
2020	1,132	3.4%	$67.7
2025	2,436	6.5%	$69.6
2028	2,865	7.3%	$67.3
Alternative Lighting Scenario			
2018	328	1.1%	$87.2
2019	677	2.0%	$89.8
2020	1,072	2.9%	$93.5
2025	2,474	6.1%	$86.3
2028	2,883	7.1%	$74.0

Source: Navigant analysis, 2016

As

Table 7 shows, under the Max Utility Benefits scenario, electric achievable potential is estimated to be 447 GWh in 2016, accumulating to 3,380 GWh by 2028. This represents a 12 percent increase in the 2018 electric savings relative to the estimated achievable potential of 399 GWh under the Reference scenario. Under the Low Utility Benefits scenario, electric achievable potential is estimated to be 374 GWh in 2018, accumulating to 2,865 GWh by 2028. This represents a 6 percent decrease in the 2018 savings relative to the estimated first-year achievable potential of 399 GWh under the Reference Scenario.

The table also reports on the percent savings relative to electric sales, and indicates the corresponding changes in those values for both the Max Utility Benefits and Low Utility Benefits scenarios. The first year savings under the Max Utility Benefits scenario is 1.4 percent while the Low Utility Benefits scenario is 1.2 percent. For the Alternative Lighting scenario, the first year savings is 1.1 percent. For comparison, the average per year incremental savings under the Reference scenario is 1.3 percent.

The corresponding first year electric budget for the Max Utility Benefits scenario would be $116.9 million, which represents a 43 percent increase relative to the $81.9 million budget under the Reference Scenario. For the Low Utility Benefits scenario, the electric budget would be $63.7 million, which represents a 30 percent decrease relative to the $81.9 million budget under the Reference Scenario.

Finally, Table 7 shows that electric achievable potential under the Alternative Lighting Scenario is estimated to be 328 GWh in 2018, rising to 2,883 GWh in 2028. This represents an 18 percent increase in electric savings relative to the Reference Scenario for 2018. The corresponding budget under the Alternative Lighting Scenario would be $87.2 million.

Table 8. Gas Achievable Potential and Budget by Scenario

Year	Cumulative Savings (1000 Dth)	Percent of Sales	Annual Budget (Million $)
Max Utility Benefits Scenario			
2018	9.6	0.6%	$27.8
2019	20.6	1.3%	$30.1
2020	32.8	2.1%	$33.3
2025	79.3	5.2%	$25.5
2028	92.5	6.0%	$22.5
Low Utility Benefits Scenario			
2018	4.9	0.3%	$10.1
2019	10.4	0.7%	$10.5
2020	16.5	1.1%	$10.9
2025	47.6	3.1%	$11.1
2028	62.0	4.1%	$10.6

Source: Navigant analysis, 2016

As

Table 8 shows, under the Max Utility Benefits scenario, gas achievable potential is estimated to be just under 1 Million Decatherms in 2018, and 9.3 Million Decatherms in 2028. This represents a 50 percent increase in the 2018 savings relative to the estimated gas achievable potential of 0.6 Million Decatherms under the Reference Scenario. Under the Low Funding scenario, achievable potential is estimated to be just under 0.5 Million Decatherms in 2018, rising to 6.2 Million Decatherms in 2028. This represents a 20 percent decrease in the 2018 gas savings relative to the estimated achievable potential of 0.6 Million Decatherms under the Reference Scenario.

The table also reports on the percent savings relative to gas sales, and indicates the corresponding changes in those values for both the Max and Low Utility Benefits scenarios. The first year savings under the Max Utility Benefits scenario is 0.6 percent while the Low Utility Benefits scenario is 0.3 percent.

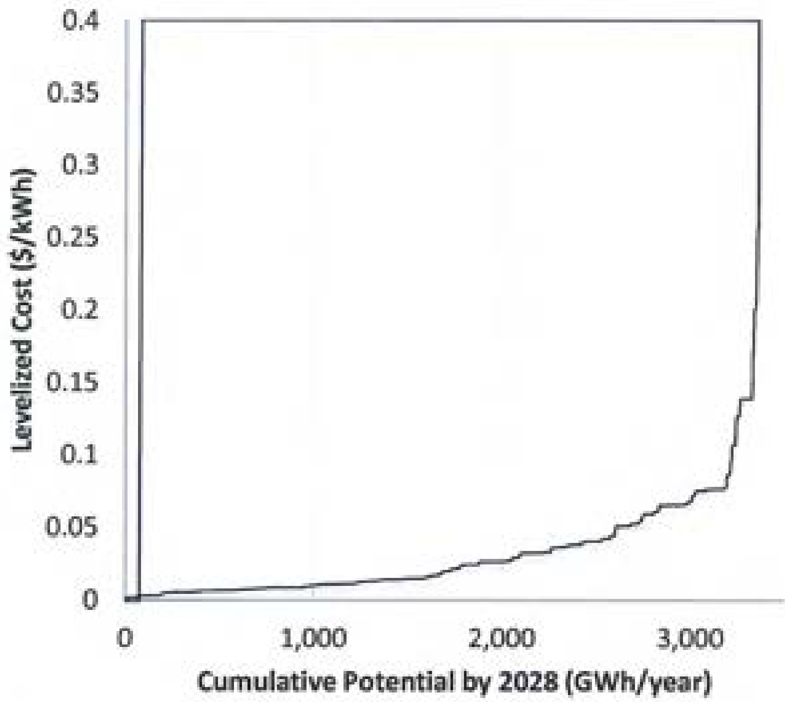
The corresponding budget for the Max Utility Benefits scenario would be $27.8 million, which represents a significant increase in funding relative to the $16.5 million gas budget under the Reference Scenario. For the Low Utility Benefits scenario, the first year gas budget would be $10.1 million, which represents a 40 percent decrease relative to the $16.5 million budget under the Reference Scenario.

Achievable Potential Supply Curves

The achievable potential supply curves are provided in this section. $/impact unit values take the cost of the measure relative to the discounted lifetime savings potential, and thus account for variable lifetimes among measures and savings persistence over time. An energy efficiency resource potential supply curve illustrates the cumulative amount of achievable potential at various price points along a range of lifetime levelized cost. All measures are plotted with their corresponding cumulative potential and the corresponding lifetime levelized cost to achieve that potential. The lowest cost measures appear on the left-hand side of the chart. Each next highest cost measure is stacked on top of the previous measures.

Figure 6 provides the supply curve results for the electric results of the reference scenario. As can be seen from the chart, roughly four-fifths of the electric achievable potential savings can be achieved for a lifetime levelized cost of under $0.05/kWh. The remaining fifth of the potential can be achieved, but at significantly higher costs.

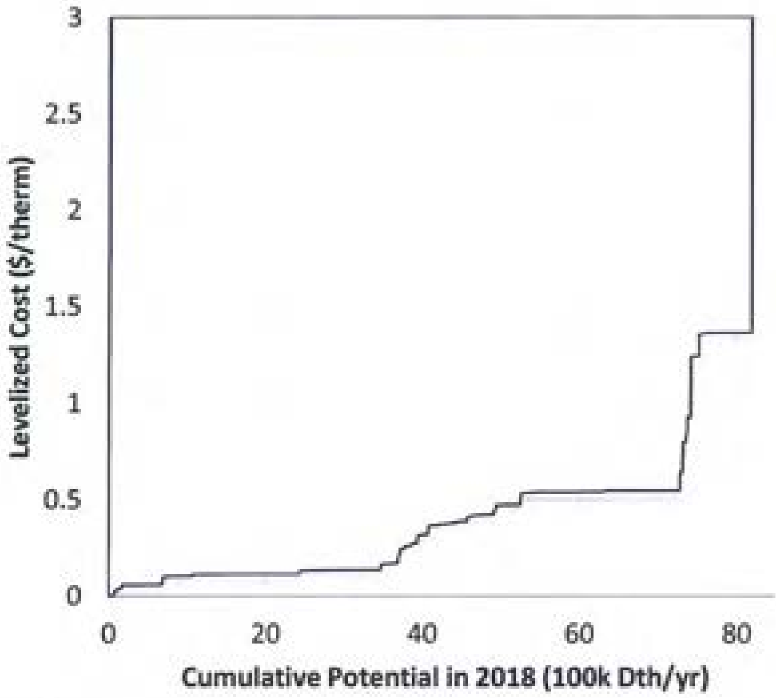
Figure 6. Electric Achievable Potential Supply Curve, All Sectors



Source: Navigant analysis, 2016

Figure 7 provides the comparable information for gas. As can be seen from the chart, roughly two-thirds of the gas achievable potential savings can be achieved for a lifetime levelized cost of under $5.0/Dth. The remaining third of the potential can be achieved, but at significantly higher costs.

Figure 7. Gas Achievable Potential Supply Curve, All Sectors



Source: Navigant analysis, 2016

Observations and Insights

This study has resulted in updated, expanded, and improved information on the Xcel Energy customer base and the potential for energy reductions that are possible through DSM programs and initiatives. While much DSM potential exists, there are unique challenges that the Xcel Energy faces in its Colorado service territory in realizing this potential:

Prior DSM Success: Xcel Energy has effectively implemented DSM programs in the Colorado service territory for many years, often exceeding goals in terms of the amount of savings achieved at some, but not all segment levels within its energy efficiency portfolio. As greater levels of DSM are implemented in the service territory and market saturation increases it will become more challenging to harvest additional savings that are represented in the DSM potential. One example of this includes residential bathroom faucet aerators, where the study results show that savings will begin to level out around 2021 as the market reaches saturation for that measure.

Codes and Standards: The challenge of continuing to capture energy efficiency DSM savings within an increasingly saturated market is exacerbated by tightening codes and standards. In particular the federal EISA lighting standards have a large impact on energy efficiency DSM potential. Codes and standards changes will also impact the savings available from measures such as commercial ice makers, Energy Star clothes washers, and a variety of commercial HVAC measures over the study period.

Increasing Costs: Changes to the portfolio measure mix that occur due to market saturation and codes and standards changes drive costs upward. In the future, while Navigant forecasts incremental achievable savings potential to begin to decline around 2021, program acquisition costs continue to increase through the majority of the forecast horizon.

Fuel Mix: Xcel Energy serves its customers combined electricity and natural gas, electricity only, and natural gas only. While this is not generally a unique situation, the combination of fuel mixes adds complexity to the marketplace in terms of energy efficiency program delivery when targeting savings for each of these fuels separately, or in combination. These additional layers of complexity include appropriately capturing program savings, cost effectiveness, and incentives without double counting across fuel types and ensuring that incentives are distributed appropriately to single fuel customers.

Varied Regions within Xcel Energy Franchise Area: Xcel Energy has two very different regions in its territory: (1) the urban and suburban communities of Denver and Boulder where access to energy efficiency services is generally more favorable; and (2) the more rural locations located to the north of Denver (plains) and to the mountain west where delivery of energy efficiency services can be challenging. Due to the nature and diversity of customers in the Xcel Energy Colorado territory, achieving market acceptance and program participation is very challenging. Outreach, education and marketing to the numerous residential and business segments, as well as the highly variable market within each of these segments, must be a high priority in any DSM program effort.

Based on the results of this Study, we recommend that additional granular analyses be undertaken on a regular basis, for the important or promising markets for energy efficiency potential. These markets include:

- Commercial and industrial/ag buildings, which represent nearly 60 percent of the electric potential, show significant promise for improving the efficiencies of HVAC and lighting systems, particularly in new buildings. Because of the large potential Navigant sees in new construction, there could be opportunity for Xcel Energy to target this program for expansion, although additional research and/or program design efforts would be required to develop specific recommendations.
- Residential buildings (single family in particular) represent significant savings opportunities for electric cooling systems, gas space heating, lighting, and electronics end-uses. Targeting deep savings within this segment after the EISA implementation will be critical to meeting Xcel Energy's savings targets in the future.
- Single-family buildings present unique opportunities for capturing energy efficiency potential for both fuels (particularly natural gas) and nearly all end-uses, with the most promising opportunities for central cooling systems, central heating systems (electric and gas), and virtually all forms of lighting.

Further primary market research efforts could be geared toward a better understanding of customer decision making about DSM and their willingness to adopt DSM and at what price. Customer panels that would regularly check the pulse of customer attitudes could contribute toward making more meaningful mid-course corrections in program designs. Because the DSM market is dynamic, multi-dimensional and subject to continuous change, taking these and other measures is essential toward ensuring that energy savings are maximized in the most cost-effective manner.

1. INTRODUCTION

This section provides an overview of the Potential Study, including background and study goals, a discussion of the report's organization and key caveats and limitations of the Potential Study.

1.1 Context and Study Goals

Navigant was retained by Xcel Energy to develop an estimate of the potential for electric and natural gas energy efficiency within demand-side management (DSM) in Xcel Energy's Colorado service territory during the 2018-2028 timeframe. Navigant has worked with Xcel Energy to develop information on current levels and patterns of energy use in Colorado, characterize potential measures which could be implemented to increase energy efficiency within DSM in the service territory, and develop an estimate of DSM potential. The technical, economic and achievable potential for energy efficiency within DSM was modeled using Navigant's proprietary DSMSim™ model.

The study data and analysis will assist Xcel Energy in informing its proposal of economically achievable goals in the next DSM Strategic Issues proceeding and in informing its development of future DSM Plans. Throughout this study, Navigant sought regular input and feedback from both internal and external stakeholders, who provided important market knowledge and industry expertise for producing a robust final study. Table 9 summarizes the various elements of the project scope.

Table 9. Summary of Project Scope

Element	Dimensions
Forms of Energy	Electricity Natural Gas
Type of Potential	Technical, Economic & Achievable Energy & Demand (from energy efficiency measures)[6]
Sectors	Residential Commercial Industrial/Ag
Climate	3 Climate Zones
Time Horizon	Year 2018 to 2028

Source: Navigant 2016.

This report is organized as follows:

[6] This study did not address the potential from demand response measures, with the exception of Xcel Energy's Saver's Switch measure. In this case, Navigant included the energy savings in the potential, but excluded the demand savings, since these are addressed in a separate study on demand response potential.

- Chapter 2 describes the approach to developing a base case projection of stocks and energy consumption, primary data collection efforts, and measure identification and characterization.
- Chapter 3 describes the approach taken to analyzing the technical potential for DSM measures, including a summary of results by sector, segment, end use and measure.
- Chapter 4 describes the approach taken to analyzing the economic potential for DSM measures, including a summary of results by sector, segment, end use and measure.
- Chapter 5 discusses the approach taken to analyzing the achievable potential for DSM measures, including a summary of results by sector, segment, end use and measure. Results of the Potential Study for achievable potential, including sensitivity analyses on achievable potential under different incentive level and other assumptions are also presented in this chapter.
- Chapter 6 summarizes the conclusions from this study.
- The report also includes a number of Appendices, which provide additional information on:
  - Overview of DSMSim™
  - Residential Survey Results
  - Commercial and Industrial Survey Results
  - Upstream Market Actor Survey Results
  - Measure Characterization Data
  - Stakeholder Presentations

1.2 Caveats and Limitations

There are several caveats and limitations associated with the results of this study, as detailed below.

1.2.1 Forecasting Limitations

Navigant obtained future energy sales forecasts from Xcel Energy that excludes the impacts of DSM programs. Navigant used these utility forecasts as the basis for developing stock projections, where sufficient and detailed information could not be extracted. Navigant has leveraged the assumptions underlying these forecasts, as much as possible, as inputs into the development of the Reference Case stock and energy savings projections.

1.2.2 Program Design

The results of this study provide a big picture view of the unmet savings potential in Xcel Energy's service territory. However, this Potential Study is not intended to provide, nor does it have information on detailed program design. Different program designs and delivery mechanisms would inevitably result in different levels of adoption of efficient technologies, which also means that the output of this study is by no means a prediction of what will occur, but rather an estimate of what could be achieved under the specific set of assumptions outlined in this study. Program design is typically a separate activity and is outside the scope of this study.

1.2.3 Measure Characterization

The scope of this study employed both primary data collection techniques and a variety of secondary data sources (e.g., technical reference manuals (TRMs), studies from other jurisdictions, etc.) for estimates of measure savings, costs and market presence (e.g., saturations and densities). Primary data, specific to Xcel Energy's Colorado service territory, was used wherever possible. Where Colorado-specific data was not available, the best available data was used. Details of primary and secondary data sources relied upon are provided in Chapter 2.

Furthermore, the team considers the measure list used in this study to appropriately focus on those technologies likely to have the highest impact on savings potential over the potential study horizon. However, there is always the possibility that emerging technologies may arise that could increase savings opportunities over the forecast horizon, and broader societal changes may impact levels of energy use in ways not anticipated in the study. Due to the significant uncertainty associated with emerging technologies, this study reflects the best available view of what is currently available on the market and does not make assumptions about emerging technologies beyond capturing a range of potential uncertainty through scenario analysis (see Section 5.3). Similarly, this study does not make assumptions about future code and standard changes beyond those already planned for the study period.

DSM potential studies must make assumptions about the adoption of technologies that inevitably come with a degree of uncertainty. While techniques such as use of payback acceptance curves and technology diffusion models are considered to provide reasonable aggregate estimates of savings potential, such techniques (which must be applied to dozens or in some cases hundreds of DSM measures) are limited in their ability to accurately predict adoption for specific measures or in specific customer segments. Model calibration steps (e.g., comparing forecast results with achieved results) seek to ground the forecasts in the real world, but inaccuracies are bound to exist the further one drills into any particular technology or segment, even if the aggregate results are considered to be reasonable. One reason that aggregate results can in many cases be more reliable than individual technology or segment results is that forecasting inaccuracies, at the measure-level will exhibit a pooling effect when aggregated up to the portfolio (whereby positive or negative differences at a finer level of aggregation can help to offset each other in an aggregate result). While more in-depth technology adoption techniques do exist (e.g., discrete choice analysis) to improve the forecast accuracy for any given technology, application of these techniques to the quantity of measures analyzed in studies such as this are not typically warranted considering the dramatic increase in costs one would have to incur to calibrate a different adoption model for every single measure.

1.2.4 Measure Interactions

Energy efficiency measures in this study are modeled independently.[7] As a result, the total aggregated energy efficiency potential estimates may be different from the actual potential available if a customer installs multiple measures in their home or business. For example, if a customer implements an operational program to review and maintain steam traps, but also installs a more efficient boiler, the savings from the efficient boiler may be reduced to the extent that the steam trap program reduces heating requirements at the boiler. However, due to the complexity of analyzing this type of interaction at scale, this study does not consider within-end-use interactions or the stacking of efficiency measures.

[7] A small number of measures, such as Lighting measures, accounted for interactions among multiple efficient measures.

This study did assess the impacts of significant cross-end-use interactions. An example of a cross-end-use interaction would be when a homeowner replaces a number of heat producing incandescent light bulbs with efficient LEDs. This impacts the cooling and heating load of the space—however slightly—by increasing the amount of heat, and decreasing the amount of cooling generated by the HVAC system.

Navigant employed the following methods to account for interactive effects:

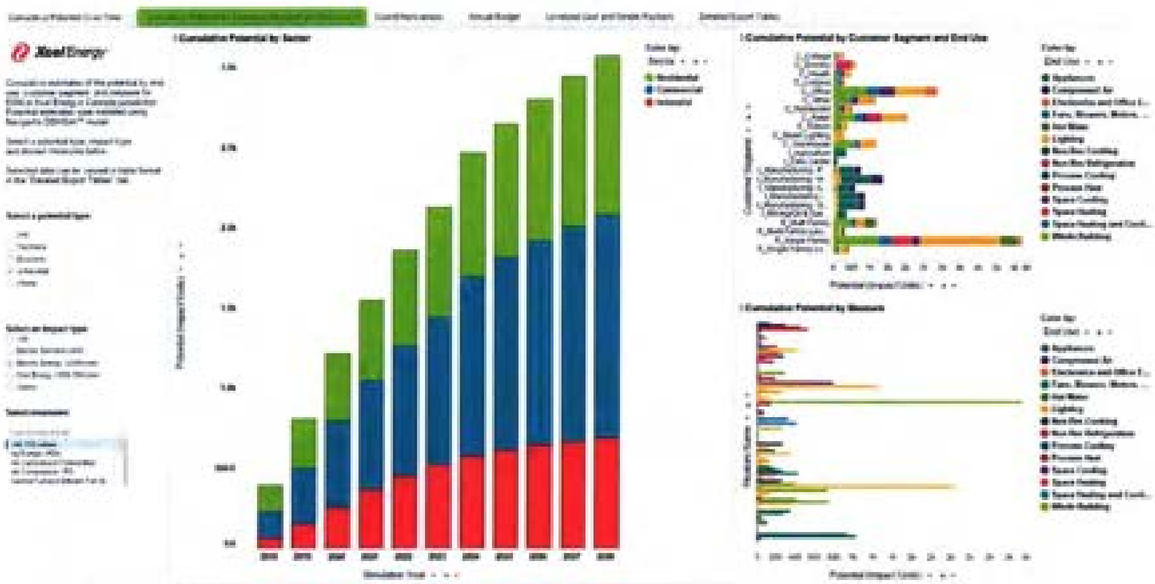
- Where measures clearly compete for the same application (e.g., CFL and LED), the team created competition groups to eliminate the potential for double counting savings
- Wherever cross-end-use interactions were appreciable (e.g., lighting and HVAC), the team characterized those interactions for both same-fuel (e.g., lighting and electric heating) and cross-fuel (e.g., lighting and gas heating) applications

1.2.5 Interpreting Results

This report includes a high-level account of savings potential results across Xcel Energy's Colorado service territory and focuses largely on aggregated forms of savings potential. Figure 8 provides results at the finest level of granularity, which is at the measure-level within each customer segment. The measure-level data is mapped to the various customer segments and end-use categories to permit a reviewer to easily create custom aggregations.

Navigant has also created an interactive web-based tool that summarizes the outputs for each DSM potential scenario that was assessed as part of this Potential Study. Along with this final report which summarizes results aggregated to the statewide level, this web-based tool, the 2016 Xcel Energy DSM Potential Study Results Viewer (Results Viewer), provides access to all detailed results from the DSMSim™ model. The Results Viewer provides the ability to manipulate and visualize model outputs from the high-level service territory standpoint all the way down to the granular climate zone-specific sector, segment, and measure level. The Results Viewer is structured to view summary results as well as detailed model outputs, as seen in Figure 8. Extracts from this viewer can be provided upon request.

Figure 8. 2016 Xcel Energy DSM Potential Study Results Viewer



Source: Navigant 2016.

1.3 Stakeholder Engagement

This study involved both internal and external stakeholder engagement efforts, as described below, to ensure robust, meaningful outputs from the study.

Navigant regularly engaged a core sub-set of Xcel Energy staff in gathering data and resources, knowledge sharing, and obtaining feedback on the Potential Study throughout the process. As part of the internal stakeholder engagement process, Navigant also met with program managers and planners from Xcel Energy in February 2016 to provide an overview of the project and gather early feedback from the broader internal team. Through the Fall of 2016, Navigant then held several working sessions with Xcel Energy to review the final results, as well as the driving assumptions and methodology underlying the results.

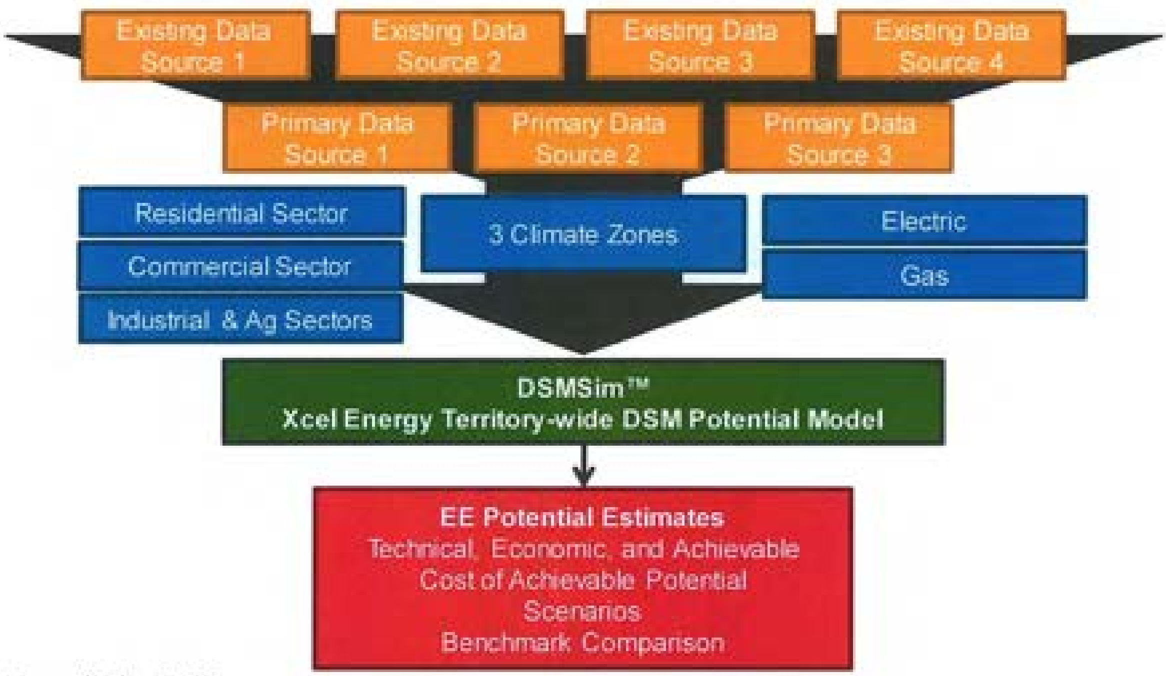
Navigant also held two briefings with key external stakeholders over the course of the study. The objective for these briefings was to ensure transparent study methods and results that are well understood by external stakeholders. The first briefing, held in February 2016, informed stakeholders on the study's methodology and the scope of technologies to be assessed. Stakeholders then had the opportunity to provide comment on the technologies considered for the analysis, with Navigant incorporating this feedback accordingly to better reflect the current regulatory and policy constructs. The second briefing, held in August 2016, then presented stakeholders with the primary data collection results and preliminary results for technical and economic potential, with the ability for stakeholders to comment on key findings prior to finalizing the results.

The incorporation of stakeholder feedback throughout the process should facilitate use of this study as a resource and a reference for both Xcel Energy and interested external DSM stakeholders.

2. APPROACH TO ESTIMATING SAVINGS

Figure 9 illustrates the overall approach to the Potential Study. In general, the Potential Study began with a detailed assessment of data sources that are specific to Xcel Energy's Colorado service territory. Navigant then supplemented those sources with primary field data collection, complemented by secondary sources. The specific sectors (residential, commercial, and industrial/ag) and the various segments within those sectors were assessed, differences in the three climate zones within the service territory were assessed from a DSM measure perspective, and impacts were reviewed for both electric and gas measures as well as measures that result in savings for both fuels. Navigant imported all of this information into the DSMSim™ model to generate territory-wide estimates of DSM potential.

Figure 9. Project Approach



Source: Navigant 2016.

Technical potential is defined as the energy savings that can be achieved assuming that all installed measures can immediately be replaced with the efficient measure, wherever technically feasible, regardless of the cost, market acceptance, or whether a measure has failed (or "burned out") and is in need of being replaced. Economic potential is a subset of technical potential, using the same assumptions regarding immediate replacement as in technical potential, but limiting the calculation only to those measures that have passed the benefit-cost test chosen for measure screening, which in this case is the modified Total Resource Cost (mTRC) test. Achievable potential is a subset of economic potential, but further considers the likely rate of DSM acquisition, which is driven by a number of factors including the rate of equipment turnover (a function of measure's lifetime), simulated incentive levels, budget constraints, consumer willingness to adopt efficient technologies, and the likely rate at which marketing activities can facilitate technology adoption.

For this resource assessment, Navigant employed its proprietary DSMSim™ potential model to estimate the technical, economic, and achievable potential for electric and gas savings. DSMSim™ is a bottom-up technology diffusion and stock tracking model implemented using a System Dynamics[8] framework. The DSMSim™ model explicitly accounts for considerations impacting retrofit, replace-on-burnout and new construction measures. For each of the replacement types, technical, economic, and achievable potential was determined and is reported in aggregate by sector, customer segment and end use. Potential estimates do not include "ancillary" savings to non-Xcel Energy utilities, such as reductions in electricity use that result indirectly from an Xcel Energy gas utility program or vice versa.

As agreed upon with Xcel Energy, the results presented in this study are *net*, rather than *gross* savings, with net-to-gross (NTG) factors applied to measure savings to account for free ridership and spillover at the measure level.

The remainder of this section describes the methodologies Navigant employed for estimating electric and natural gas savings across Xcel Energy's Colorado service territory, including the approach taken in development of the base case forecast, the primary data collection techniques employed, and the approach to characterizing the energy efficiency measures used in the analysis.

2.1 Base Case Forecast

This section describes the approach Navigant used for developing the base case forecast of electric and natural gas sales over the study period in Xcel Energy's Colorado service territory, including the segmentation of sales by climate zone, housing or building type, income, and fuel type.

In general, Navigant used Xcel Energy-specific data wherever possible, supplementing that data with information available from neighboring and comparable jurisdictions and other sources, such as Energy Information Administration (EIA) data. This approach resulted in the use of primary data collection to supplement the available secondary data as required.

2.1.1 Approach to Base Case Forecast

To estimate the DSM potential within Xcel Energy's Colorado territory, Navigant requested sales and customer forecasts without the impact of DSM programs from Xcel Energy. Navigant then developed projections of housing and commercial building stocks, based on Xcel Energy's long term sales forecasts and other information, such as EIA data. Navigant modeled the potential for DSM based on these resulting stocks and the changing proportion of new and existing buildings. In each sector, new construction savings opportunities were modeled as a function of forecasted new building stock and energy sales.Navigant did not develop an independent forecast of electricity and natural gas energy requirements.

Navigant divided electric and natural gas customers into "segments" with similar patterns of energy use and efficiency opportunities. Table 10 shows the segmentation used for the Potential Study:

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[8] See Sterman, John D. *Business Dynamics: Systems Thinking and Modeling for a Complex World*, Irwin McGraw-Hill, 2000 for detail on System Dynamics modelling. Also see http://en.wikipedia.org/wiki/System_dynamics for a high-level overview.

- Navigant divided residential customers into four segments, based on the type of structure and income level (single family, multi-family, single family low income, and multi-family low income).
- The commercial sector was divided into ten segments.
- The industrial sector was divided into eight segments, including agriculture, five different types of manufacturing, resource extraction (i.e., mining/oil and gas), and data centers. While less robust data was generally available for many of these industrial customer segments (e.g., data centers), these segments were included in the analysis with the acknowledgement that they have growing importance and market share within Xcel Energy's Colorado territory over the next ten years.[9]

Table 10. Customer Segments by Sector

Residential	Commercial	Industrial
Single Family	Office	Agriculture
Multi-Family	Retail	Manufacturing – Metal
Single Family - Low Income	Restaurant	Mining/Oil & Gas Extraction
Multi-Family - Low Income	Grocery	Manufacturing – Light
	Warehouse	Manufacturing – Heavy
	School	Manufacturing – Specialty
	College	Manufacturing - Food & Beverage
	Health	Data Center
	Lodging	
	Other	

Source: Navigant 2016.

Navigant further classified customers into one of three climate zones within Xcel Energy's territory and the type of energy they purchase from Xcel Energy (i.e., electricity only, natural gas only, or both electricity and natural gas). The intersection of these classifications resulted in 198 modeling sub-segments:

22 Customer Segments X 3 Fuel Types X 3 Climate Zones = 198 Modeling Sub-Segments

[9] This study includes the energy consumption from the marijuana industry as part of the Agriculture segment and does not consider it as a specific segment. While data provided by Xcel Energy suggests that energy consumption from the marijuana industry is growing rapidly, with as much as a 345% increase in sales since January 2011, there is still insufficient data available to segment the industry separately within the analysis and adequately characterize energy efficiency opportunities. This is recommended as an area for future study.

2.1.2 Base Year Calibration

This section discusses some of the trends observed in Xcel Energy's sales and customer forecast, as well as the impacts these trends may have on the Potential Study results.

The electric sales forecast provided by Xcel Energy reflects a spike in electric sales growth from 2019-2021 for C&I customers, due to new loads from oil and gas exploration/extraction. However, this increase in sales does not show up significantly in the C&I potential forecasts, since this effect primarily affects the oil and gas exploration/extraction industries, which do not historically present significant opportunities for DSM potential.

For natural gas, the sales forecast for the next 10 years is quite variable, with sales projected to decline through 2020, and increase sharply rapidly from 2021-2023, before flattening out though the end of the forecast horizon. This variability has a visible impact on study results, including the incremental potential and annual net benefits during that time, primarily through the impact on new construction measures.

Generally, the growth exhibited in Xcel Energy's customer forecast is offset by declines in use per customer over time. For C&I customers, sales over the next 10 years decline an average of -0.5 percent annually, due to customers shifting to Transport service.[10]

2.2 Primary Data Collection

For this project, Xcel Energy chose to include an enhanced data collection process that included a review of existing secondary data and a primary data collection process that supplemented those secondary sources. Through the primary data collection process, Navigant emphasized the collection of Xcel Energy-specific data that improved the quality of the analysis and was not already available through recent Xcel Energy studies. For example, Navigant included only a limited number of questions on lighting in the survey instruments, given that Xcel Energy recently completed a comprehensive lighting review in their 2015 Lighting Study that adequately informed the potential study.

As discussed in the subsections below, the primary data collection included customer online, phone, and onsite surveys focused on collecting customer characteristic and equipment saturation data, as well as upstream market actor surveys that informed an understanding of market trends.

2.2.1 Approach to Customer Primary Data Collection

Navigant used a combination of customer phone surveys, online surveys, and onsite visits to collect primary data regarding electricity and natural gas usage in Xcel Energy's Colorado service territory. Navigant employed double ratio nested sampling design to randomly select residential and C&I customers for the surveys and onsite visits. Double ratio nested sampling is an efficient sample design, which utilizes two data collection phases: The first phase was used to sample a large number of participants from the population for phone or online surveys. This was augmented by a more involved and detailed second phase applied to a select subset of participants for onsite verification.

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[10] Transport customers are not eligible to participate in DSM in Xcel Energy's territory. Both sales and savings from transport customers were excluded from this analysis.

In the first phase, Navigant randomly sampled 1,207 residential and 357 C&I customers for online and phone surveys from the total customer population in Xcel Energy's Colorado service territory. Navigant stratified the sample based on customers' key characteristics, such as fuel type and building type, and designed the sample with the goal of maintaining a confidence level of 90 percent with a +/- 10 percent margin of error across each sector. Navigant selected Tetra Tech[11] to conduct the online and phone surveys. Tetra Tech ultimately completed 1,499 residential and 358 C&I customer surveys, exceeding the targets and reaching 90/10 in almost all strata.

In the second phase of nested sampling, Navigant randomly sampled 100 residential customers and 50 C&I customers out of the completed online and phone surveys for onsite verification. Table 11 summarizes the stratification, survey type, randomly selected sample sizes, and the number of completes for residential and C&I customers.

Table 11. Survey and Onsite Sample and Number of Completes

Sector	Stratification	Survey Type	Survey Sample	Survey Completes	Onsite Sample	Onsite Completes
Residential	Home Type Income Energy Use Climate Zone Fuel Type	Online[12]	1,207	1,499	100	97
Commercial, Industrial & Agriculture (C&I)	Business Segment Fuel Type[13]	Phone	357	358	50	50

Source: Navigant 2016.

2.2.2 Residential Online Survey

The primary objectives of the residential online survey included determining Xcel Energy's residential customer characteristics (e.g., home type, size, age, occupancy, and energy usage patterns), energy types used, and equipment characteristics. This information was then used to help develop estimates of equipment saturations for residential DSM measures. The approach taken in the survey was to focus on questions which residents can realistically answer, rather than asking more technical questions about efficiency levels. Information on equipment age and characteristics helped to inform estimates of equipment efficiency levels in combination with the secondary data discussed in Section 2.3.

Navigant determined that the best, most effective and economic method for collecting data from residential customers was to use an online survey with the email addresses available through Xcel Energy's customer database.[14]

[11] http://www.tetratech.com/

[12] Tetra Tech completed a limited number of phone surveys to increase response rate in two harder-to-reach, smaller strata (i.e., gas-only low income customers in climate zones 6 and 7).

[13] Due to the large number of business segments, Navigant did not further stratify C&I by climate zone.

Table 12 shows the stratification for residential customers and the number of completed surveys in each stratum, with 90/10 statistical confidence and precision achieved across the residential sector and for nearly every stratum.

Table 12. Stratification of Completed Residential Customer Surveys

Segment	Electric Only	Gas Only	Electric & Gas
Zone 5-LI	71	58	57
Zone 5 - NLI - High	50	60	78
Zone 5 - NLI - Low	71	55	63
Zone 6-LI	57	12	48
Zone 6 - NLI - High	41	52	48
Zone 6 - NLI - Low	76	64	36
Zone 7-LI	45	10	73
Zone 7 - NLI - High	77	61	45
Zone 7 - NLI – Low	67	50	74

Source: Navigant 2016.

Note: LI= Low income, NLI= Non-low Income, Low =Low energy usage, High = High energy usage, Zone 5, 6, 7=Xcel Energy Energy Climate Zones

2.2.3 C&I Telephone Survey

The primary objectives of the C&I telephone survey included determining firmographics of the businesses in Xcel Energy's service territory (e.g., facility type, size, age, occupancy, usage patterns), equipment saturations, energy types used, and equipment characteristics. As with the residential survey, the questions were designed to elicit information which respondents can confidently provide regarding equipment types, energy sources used, and equipment age, as well as information regarding their firm and facilities. Table 13 shows the stratification for C&I customers and the number of completed surveys in each stratum, with 90/10 statistical confidence and precision achieved across the residential sector and for nearly every stratum.

Table 13. Stratification of Completed Commercial Customer Surveys

Segment	Electric Only	Gas Only	Electric & Gas
Agriculture	16	16	8
Data Center	22	13	8
Education	11	11	9
Grocery-Retail	19	9	8
Health - Lodging	11	15	8
Manufacturing	12	14	9

[14] Navigant reviewed Xcel Energy's customer data and confirmed that no appreciable bias would be introduced for low income customers by only targeting customers with email addresses. Navigant and Tetra Tech also conducted a limited number of phone follow-up surveys to provide additional outreach to these customers.

Office	14	10	8
Resource Extraction	11	8	8
Restaurants	26	11	8
Warehouse-Other	17	9	9

Source: Navigant 2016.

2.2.4 Customer Onsite Survey

The primary objective of the onsite visits was to validate data collected through the surveys with a representative sub-sample of the surveyed customers. Based on Navigant's double nested ratio sampling design, the selected onsite sample was representative of the survey sample.

The site visits consisted of trained Navigant staff walking through the home or facility and verifying that the equipment in the building matched the participant's survey responses. The validation process focused on mitigating any potential self-reporting bias present in the phone and online surveys by verifying the survey responses and updating any incomplete or incorrect information.

Both the survey and onsite primary data collection included categorical and numerical questions, which were used in the survey analysis to calculate the appropriate saturation and density levels as inputs for the potential model. Numerical questions asked the count of the equipment units (e.g., number of refrigerators) whereas categorical questions asked the type of equipment (e.g., Energy Star versus standard refrigerators) in a specific household or business. Details of the survey analysis are provided in Section 2.2.5.

2.2.5 Customer Survey Analysis

Navigant compared the data collected through onsite visits from residential and C&I customers with the online and phone survey responses to calculate adjusted saturations and densities of various end uses and energy efficient equipment. Navigant then used these adjusted values to update and calibrate the measure characterization and select global inputs in the model. For the purposes of this analysis:

Saturation is defined as the percent of a given customer segment with a given type of end use. Some examples of survey questions that yielded saturation values include:

Q: *"Approximately, what percent of your home's square footage is heated?"*

Q: *"What percent of the space occupied by your business is air-conditioned during the summer months?"*

Density is defined as the quantity of efficient equipment units per household (for residential) or per square feet (for C&I) of a customer segment. Some examples of survey questions that yielded density values include:

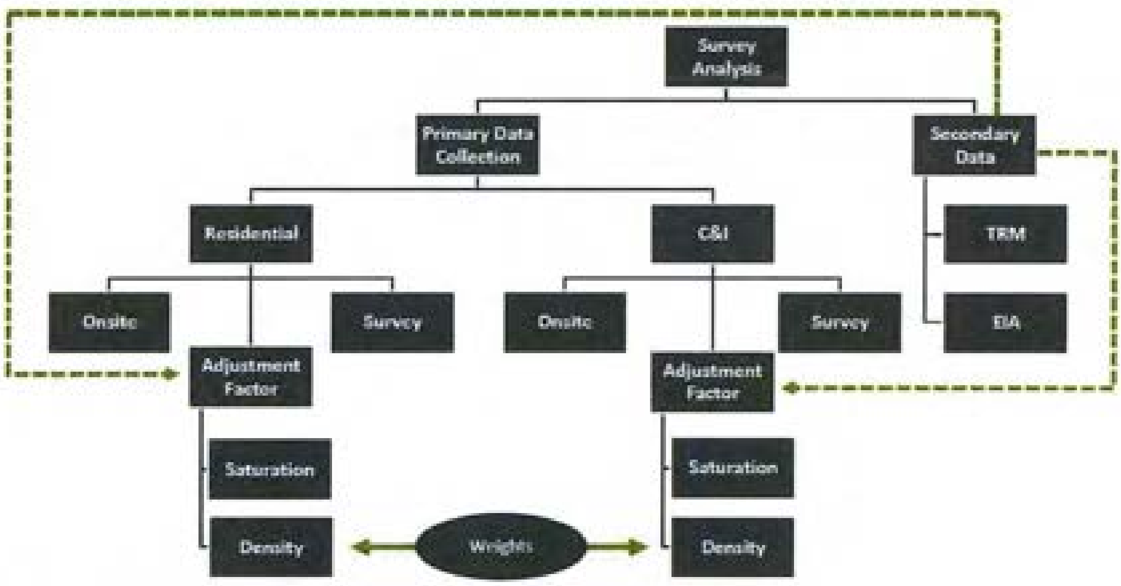
Q: *"For each of the following appliances and electronics, how many are in use in your household?"*

Q: *"Which of the following types of refrigeration equipment is present at your facility? How many?"*

Navigant's analysis of primary data included the following steps, with a summary overview provided in Figure 10:

1. Validated the responses from surveys (i.e., phone and online) with the onsite data for both residential and C&I customers. This step included comparing the survey responses with the onsite data and developing adjustment factors for the whole sample based on the differences in survey and onsite responses.[15]
2. Aggregated adjusted saturation levels by home type for residential customers and by fuel type for C&I customers. Aggregated C&I adjusted density values by customer segment (e.g., Office, Retail, etc.) and residential adjusted density values by home type, income, fuel type, and climate zone.[16]
3. Adjusted survey results using the adjustment factors developed in (2), while applying a weighting factor to maintain the representativeness of each stratum developed for both residential and C&I customers.
4. Updated the saturation and density values used for measure characterization and select global inputs with primary data.

Figure 10. Summary of the Primary Data Collection and Survey Analysis



Source: Navigant 2016.

In some cases, sample sizes were too small to calculate statistically valid adjustment factors, either due to incomplete customer responses for particular questions or some of the smaller C&I customer segments having a limited number of onsite visits completed. In these cases, the Navigant team leveraged secondary data sources, including EIA data, TRMs, industry case studies, and, for the residential sector,

[15] Navigant calculated the adjustment factors as the median value of the ratio of the number of matched onsite and survey responses to the total responses within a segment.

[16] Navigant took this aggregation step where there were insufficient observations in certain strata, with a weighting applied to maintain the representativeness of the initial stratification.

Xcel Energy's 2016 Home Use Study for saturation and density information. As mentioned above, Navigant used the 2015 Lighting Study to inform the saturation and density information for all residential and C&I lighting measures.

2.2.6 Upstream Market Actor Survey

In an effort to supplement data collection efforts on measures and savings potential in Xcel Energy's Colorado territories, the research team conducted parallel market actor surveys to collect qualitative data on market trends. This section provides a detailed description of the survey methodology, with discussion of the findings presented in Section 5.4.

In total, the research team targeted 25 complete surveys across Xcel Energy's Colorado territory, with a goal of speaking to market actors across diverse end use types and customer sectors. Navigant received a list of contacts from Xcel Energy derived from their program contacts. Navigant used this list of contacts to pull an initial survey sample organized by market actor type.[17] Table 14 shows initial targets for each market actor type, as well as completed surveys in each category. Navigant derived individual targets based on their relative representation in the sample population.

Table 14. Market Actor Survey Disposition Summary

Sector	Market Actor Type	Target	Complete
Residential	Implementer	2	2
	Distributor	4	3
	Contractor	4	5
C&I	Implementer	2	2
	Distributor	4	5
	Contractor	4	4
	Retailer	2	3
	Manufacturer	3	2
TOTAL		**25**	**26**

Source: Navigant Analysis, 2016

The research team strived to include a diverse set of market actors from both the residential and C&I sectors, as well as striving for diversity in customer segment and end use served. Navigant staff contacted market actors by phone in May 2016 to conduct the 5-10 minute surveys, ultimately completing a total of 26 surveys.

[17] To develop the survey sample, Navigant assigned a target number of completes to each category of market actors (i.e., distributors, contractors, implementers, retailers, manufacturers) provided by Xcel Energy, based on a combination of how many players there are and their relative direct experience with end user and the market. Navigant prioritized contacts who have multiple areas of expertise, technology-wise, to cover a greater breadth of market insight for an individual interview, as well as market actors identified by Xcel Energy as top performers (i.e., greatest volume). Finally, Navigant reviewed the sample to ensure that the market actors represented all major DSM technology types.

A full copy of the survey can be found in Appendix D.

2.3 Measure Characterization

Navigant fully characterized 178 measures across the residential, commercial, industrial, and agricultural sectors, covering electric and natural gas fuel types. The team prioritized measures with high impact, data availability, and most likely to be cost-effective as thresholds for inclusion into DSMSim™.

2.3.1 Approach to Measure Characterization

Navigant developed a comprehensive measure list of energy efficiency measures likely to contribute to economic potential. The team reviewed current Xcel Energy program offerings, previous Xcel Energy potential studies, and potential model measure lists from other jurisdictions to identify DSM measures with the highest expected economic impact. The team supplemented the measure list using potential studies from British Columbia, Energy Trust of Oregon, Arkansas, Pennsylvania, and Illinois, as well as technical resource manuals (TRMs).

Navigant worked with Xcel Energy and external stakeholders to finalize the measure list and ensure it contained technologies viable for future Xcel Energy program planning activities. In total, Navigant reviewed 258 measures and, through discussions with Xcel Energy and stakeholders, moved forward with 178 measures for analysis. Table 15 shows the number of measures by sector and fuel type, while Appendix E.1 provides the final measure list and assumptions, as well as the measures that were screened out from the final list.

Table 15. Number of Measures by Sector and Fuel Type

Sector	Measures
Residential	58
Commercial	69
Industrial	51
Total	**178**

Fuel Type	Measures
Electric Only	119
Gas Only	33
Both	26
Total	**178**

Source: Navigant 2016.

2.3.2 Measure Characterization Key Parameters

The measure characterization effort consisted of defining nearly 50 individual parameters for each of the 178 measures included in this study. This section defines the top 10 key parameters and how they impact technical and economic potential savings estimates. Appendix E provides the measure-level data used in the analysis for each of the parameters discussed below.

1. **Measure Definition**: The team used the following variables to qualitatively define each characterized measure:
    - ***Replacement Type***: Replacing the baseline technology with the efficient technology can occur in three variations:
        i. Retrofit (RET): where the model considers the baseline to be the existing equipment, and uses the energy and demand savings between the existing equipment and the efficient technology during technical potential calculations. RET also applies the full installed cost of the efficient equipment during the economic screening.
        ii. Replace On Burnout (ROB): where the model considers the baseline to be the code-compliant technology option, and uses the energy and demand savings between the current code option and the efficient technology during technical potential calculations. ROB also applies the incremental cost between the efficient and code-compliant equipment during the economic screening.
        iii. New Construction (NEW): where the model considers the baseline to be the least cost, code-compliant option, and uses the energy and demand savings between this specific current code option and the efficient technology during technical potential calculations. NEW also applies the incremental cost between the efficient and code-compliant equipment during the economic screening.
    - ***Baseline Definition***: Describes the baseline technology.
    - ***DSM Definition***: Describes the efficient technology set to replace the baseline technology.
    - ***Unit Basis***: The normalizing unit for energy, demand, cost, and density estimates.
2. **Regional, Sector, and End-use Mapping:** The team mapped each measure to the appropriate customer segments, sectors, fuel types, and climate zones across Xcel Energy's service territory. Navigant characterized weather dependent measures into three climate zones to account for changes in climate that impact energy savings.
3. **Annual Energy Consumption:** The annual energy consumption in kilowatt-hours (kWh) or therms for each of the base and energy-efficient technologies.
4. **Coincident Electric Demand**: The peak coincident demand in kilowatts (kW) for each of the base and energy-efficient technologies.
5. **Fuel Type Applicability Multipliers**: Defines the percentage of stock that is applicable to a measure, given a specified heating and cooling configuration. For example, for a given customer segment, stock for the measure might be split 60 percent for gas heat, electric cool buildings versus 40 percent electric heat, electric cool buildings.
6. **Measure Lifetime:** The lifetime in years for the base and energy-efficient technologies. The base and efficient lifetime only differ in instances where the two cases represent inherently different technologies, such as light-emitting diodes (LEDs) or compact fluorescent lamp (CFL) bulbs compared to a baseline incandescent bulb.

7. **Incremental Costs:** The incremental cost between the assumed baseline and efficient technology, using the following variables:
   - ***Base Costs***: The cost of the base equipment, including both material and labor costs
   - ***EE Costs:*** The cost of the energy-efficient equipment
8. **Technology Densities**: This study defines "density" as the penetration or saturation of the baseline and efficient technologies across Xcel Energy's territory. For residential, these saturations are on a per home basis, for commercial they are per 1,000 square feet of building space, and for industrial they are based on energy consumption.[18]
   - ***Base Initial Saturation***: The saturation of the baseline equipment in a territory for a given customer segment
   - ***EE Initial Saturation:*** The saturation of the efficient equipment in a territory for a given customer segment
   - ***Total Maximum Density***: The total number of both the baseline and efficient units in a territory for a given technology
9. **Technology Applicability:** The percentage of the base technology that can be reasonably and practically replaced with the specified efficient technology. For instance, occupancy sensors are only practical for certain interior lighting fixtures (an applicability less than 1.0), while all existing incandescent exit signs can be replaced with efficient LED signs (an applicability of 1.0).
10. **Competition Group**: The team combined efficient measures competing for the same baseline technology density into a single competition group to avoid the double-counting of savings. (Section 3.1.3 provides further explanation on competition groups.)

2.3.3 Measure Characterization Approaches and Sources

This section provides approaches and sources for the main measure characterization variables.

Industry practice in developing market characterizations for DSM assessments is to utilize utility-specific primary data, baseline analyses, and studies where possible. Where such information was not available, comparable data was utilized from utilities located in neighboring states or other secondary sources, such as EIA and Database for Energy Efficient Resources (DEER).

2.3.3.1 Energy and Demand Savings

Navigant took three general bottom-up approaches to analyzing measure energy and demand savings:

1. **Program Evaluation Data:** Navigant used measure specific program evaluation data from Xcel Energy to inform energy savings for the majority of measures.
2. **TRM Standard Algorithms:** Navigant used TRM standard algorithms for unit energy savings and demand savings calculations for measures without program data.
3. **Engineering Analysis:** Navigant used appropriate engineering algorithms to calculate energy savings for any measures not included in Xcel Energy programs or available TRMs.

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[18] Navigant sourced density estimates from the residential end-use survey (REUS), commercial end-use survey (CEUS), Xcel Energy program data, and other related secondary resources.

2.3.3.2 Incremental Costs

Navigant relied primarily on Xcel Energy-provided program data and TRM data for incremental cost data. Navigant conducted secondary research and used other publicly available cost data sources, such as the DEER and ENERGY STAR® for all other cost data.

2.3.3.3 Building Stock and Densities

The Residential 2016 Home Use Study, the 2015 Lighting Audit Data, and the primary data collection effort by Navigant and TetraTech provided measure density and saturation data for residential and C&I measures. In the event that no measure information was obtained from the above listed sources, Navigant leveraged other jurisdiction TRMs and previously conducted potential studies. The Home Use Study also provided information on fuel types and equipment shares by fuel type, where primary data was not available. Section 2.2.5 discusses the use of primary versus secondary data for density and saturation inputs in more detail.

2.3.4 Codes and Standards Adjustments

This study incorporates the codes and standards changes that are currently planned for the study period and documented through the U.S. Department of Energy (DOE)[19] for standard changes and the 2015 International Energy Conservation Code (IECC) for code changes. Navigant also incorporated Xcel Energy stakeholder feedback on when to use an IECC baseline rather than a DOE baseline for specific measures.

As future codes and standards take effect, the energy savings from existing measures impacted by these codes and standards diminishes. Navigant accounts for the impact of codes and standards by baseline energy and cost multipliers, presented in Appendix E.2, which reduce the baseline equipment consumption starting from the year a particular code or standard takes effect. The baseline cost of an efficient measure impacted by codes and standards will often increase upon implementation of the code. Savings potential presented in the model results includes savings potential from codes and standards, and measure-level results show their contribution to overall potential.

The DOE Technical Support Documents (TSD)[20] contains information on energy and cost impact of each appliance standard. Engineering analysis is available in Chapter 5 of the TSD, energy use analysis is available in Chapter 7, and cost impact is available in Chapter 8. Navigant sourced the codes and standards multipliers from the DOE's analysis and/or assumptions. Technologies that will be affected by foreseeable standards include general service lamps, air source heat pumps, and packaged terminal air conditioners, with the complete list available in Appendix E.2.

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[19] Standard changes considered in this analysis from the DOE include those listed at: http://energy.gov/eere/buildings/standards-and-test-procedures.

[20] Appliance standards rulemaking notices and Technical Support Documents can be found at: http://energy.gov/eere/buildings/current-rulemakings-and-notices

2.3.5 Approach for Dual Fuel Measures

This section describes Navigant's methodology for addressing measures that can provide both electric and natural gas energy savings, including programmable thermostats, insulation, and Home Energy Reports. Xcel Energy has some customers to which it provides both gas and electric service, some to which it provides electric only service, and some to which it provides gas only service. To best capture the variable savings that some measures will have across these different types of customers, Navigant characterized measures that have both gas and electric savings differently depending on the utility service type and heating fuel characteristics of the customer. This allowed both gas and electric savings potential, cost effectiveness, and incentives to be captured without the risk of double counting.

The approach for dual fuel measures is described in more detail here:

- Navigant modeled the majority of dual fuel savings measures separately for each customer heating fuel type, utility service type, and climate zone. This resulted in a unique characterization for each utility service type combination in each climate zone, based on the following:
    - Utility service types included Gas Only, Electric Only, and Both. Customers with Gas Only or Electric Only have another utility, other than Xcel Energy, deliver the complementary fuel.
    - Fuel share splits allowed Navigant to allocate HVAC load between customer types: Gas Heat, Electric Cool; Gas Heat, No Cool; Electric Heat, Electric Cool; and Electric Heat No Cool.
    - Single-measure characterization ensures that cost-effectiveness tests capture gas and electric savings in a straight-forward manner.
- For several measures, such as whole home or whole building new construction measures, savings were tied directly to the sales/consumption for a given customer segment. Because the savings were tied directly to either gas or electric sales, the savings were converted to a single primary fuel for each customer type, such that the entire stream of savings could be captured by the cost effectiveness test.

3. TECHNICAL POTENTIAL FORECAST

This section describes Navigant's approach to calculating technical potential and presents the results for Xcel Energy's Colorado service territory.

3.1 Approach to Estimating Technical Potential

This study defines technical potential as the total energy savings available assuming that all installed measures can *immediately* be replaced with the "efficient" measure/technology—wherever technically feasible—regardless of the cost, market acceptance, or whether a measure has failed and must be replaced.

Navigant used its state-of-the-art DSMSim™ model to estimate the technical potential for demand side resources in Xcel Energy's Colorado service territory. DSMSim™ is a bottom-up technology-diffusion and stock-tracking model implemented using a System Dynamics framework.[21]

Navigant's modeling approach considers an energy-efficient measure to be any change made to a building, piece of equipment, process, or behaviour that could save energy. The savings can be defined in numerous ways, depending on which method is most appropriate for a given measure. Measures like residential water heaters are best characterized as some fixed amount of savings per water heater; savings for measures like commercial building controls and automation systems are typically characterized as a percentage of customer segment consumption; and measures like industrial ventilation heat recovery are characterized as a percentage of end-use consumption. The DSMSim™ model can appropriately handle savings characterizations for all three methods.

Navigant assumes that the baseline for the technical potential of a given measure in a given year is the baseline applicable in that year after adjusting for code and standard changes. As an example, the baseline in the technical potential for general service lighting changes from an incandescent to a compact fluorescent (CFL) in 2020 when the federal standard changes.

The calculation of technical potential in this study differs depending on the assumed measure replacement type. Technical potential is calculated on a per-measure basis and includes estimates of savings per unit, measure density (e.g., quantity of measures per home) and total building stock in each service territory. The study accounts for three replacement types, where potential from retrofit and replace-on-burnout measures are calculated differently from potential for new measures. The formulae used to calculate technical potential by replacement type are shown below.

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[21] See Sterman, John D. *Business Dynamics: Systems Thinking and Modeling for a Complex World*, Irwin McGraw-Hill. 2000 for detail on System Dynamics modelling. Also see http://en.wikipedia.org/wiki/System_dynamics for a high-level overview.

3.1.1 New Construction Measures

The cost of implementing new construction (NEW) measures is incremental to the cost of a baseline (and less efficient) measure. However, new construction technical potential is driven by equipment installations in new building stock rather than by equipment in existing building stock.[22] New building stock is added to keep up with forecast growth in total building stock and to replace existing stock that is demolished each year. Demolished (sometimes called replacement) stock is calculated as a percentage of existing stock in each year, and this study uses a demolition rate of 0.5 percent per year for residential and commercial stock and 0 percent for industrial stock. New building stock (the sum of growth in building stock and replacement of demolished stock) determines the incremental annual addition to technical potential, which is then added to totals from previous years to calculate the total potential in any given year. The equations used to calculate technical potential for new construction measures are provided below.

Equation 1. Annual Incremental NEW Technical Potential (AITP)

$AITP_{YEAR}$ = New $Buildings_{YEAR}$ (e.g., buildings/year[23]) X Measure Density (e.g., widgets/building) X $Savings_{YEAR}$ (e.g., kWh/widget) X Technical Suitability (dimensionless)

Equation 2. Total NEW Technical Potential (TTP)

$$TTP = \sum_{YEAR=2016}^{YEAR=2035} AITP_{YEAR}$$

3.1.2 Retrofit and Replace-on-Burnout Measures

Retrofit (RET) measures, commonly referred to as advancement or early-retirement measures, are replacements of existing equipment before the equipment fails. Retrofit measures can also be efficient processes that are not currently in place and that are not required for operational purposes. Retrofit measures incur the full cost of implementation rather than incremental costs to some other baseline technology or process because the customer could choose not to replace the measure and would therefore incur no costs. In contrast, replace-on-burnout (ROB) measures, sometimes referred to as lost-opportunity measures, are replacements of existing equipment that have failed and must be replaced, or they are existing processes that must be renewed. Because the failure of the existing measure requires a capital investment by the customer, the cost of implementing replace-on-burnout measures is always incremental to the cost of a baseline (and less efficient) measure.

Retrofit and replace-on-burnout measures have a different meaning for technical potential compared with new construction measures. In any given year, we use the entire building stock for the calculation of technical potential.[24] This method does not limit the calculated technical potential to any pre-assumed rate of adoption of retrofit measures. Existing building stock is reduced each year by the quantity of demolished building stock in that year and does not include new building stock that is added throughout the simulation. For retrofit and replace-on-burnout measures, annual potential is equal to total potential,

[22] In some cases, customer-segment-level and end-use-level consumption are used as proxies for building stock. These consumption figures are treated like building stock in that they are subject to demolition rates and stock-tracking dynamics.

[23] Units for new building stock and measure densities may vary by measure and customer segment (e.g., 1,000 square meters of building space, number of residential homes, customer-segment consumption, etc.).

[24] In some cases, customer-segment-level and end-use-level consumption/sales are used as proxies for building stock. These consumption/sales figures are treated like building stock in that they are subject to demolition rates and stock-tracking dynamics.

thus offering an *instantaneous* view of technical potential. The equation used to calculate technical potential for retrofit and replace-on-burnout measures is provided below.

Equation 3. Annual/Total RET/ROB Technical Savings Potential

Total Potential = Existing Building Stock$_{YEAR}$ (e.g., buildings[25]) X Measure Density (e.g., widgets/building) X Savings$_{YEAR}$ (e.g., kWh/widget) X Technical Suitability (dimensionless)

3.1.3 Competition Groups

Navigant's modeling approach recognizes that some efficient technologies will compete against each other in the calculation of potential. The study defines "competition" as an efficient measure competing for the same installation as another efficient measure. For instance, a consumer has the choice to install a CFL or a LED lamp in a single socket, but not both. These efficient technologies compete for the same installation.

General characteristics of competing technologies used to define competition groups in this study include the following:

- Competing efficient technologies share the same baseline technology characteristics, including baseline technology densities, costs, and consumption
- The total (baseline plus efficient) measure densities of competing efficient technologies are the same
- Installation of competing technologies is mutually exclusive (i.e., installing one precludes installation of the others for that application)
- Competing technologies share the same replacement type (RET, ROB, or NEW)

To address the overlapping nature of measures within a competition group, Navigant's analysis only selects one measure per competition group to include in the *summation* of technical potential across measures (e.g., at the end-use, customer segment, sector, service territory, or total level). The measure with the largest energy savings potential in a given competition group is used for calculating total technical potential of that competition group. This approach ensures that the aggregated technical potential does not double-count savings. However, the model still calculates the technical potential for each individual measure outside of the summations.

[25] Units for building stock and measure densities may vary by measure and customer segment (e.g., 1,000 square meters of building space, number of residential homes, customer-segment consumption/sales, etc.).

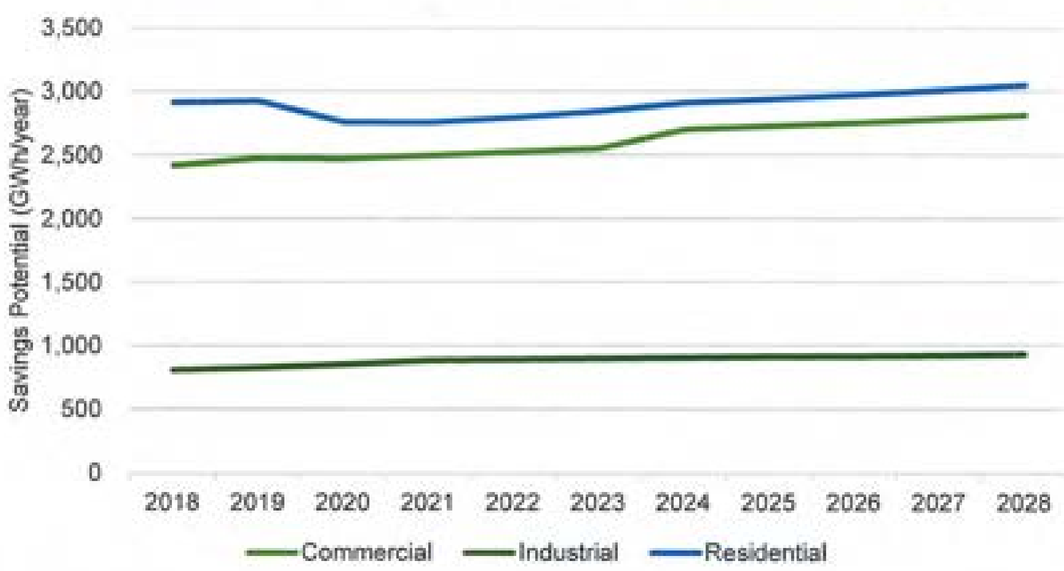
3.2 Technical Potential Results

This section provides the technical savings potential calculated through DSMSim™ at varying levels of aggregation. Results are shown by sector, customer segment, and highest-impact measures.

3.2.1 Results by Sector

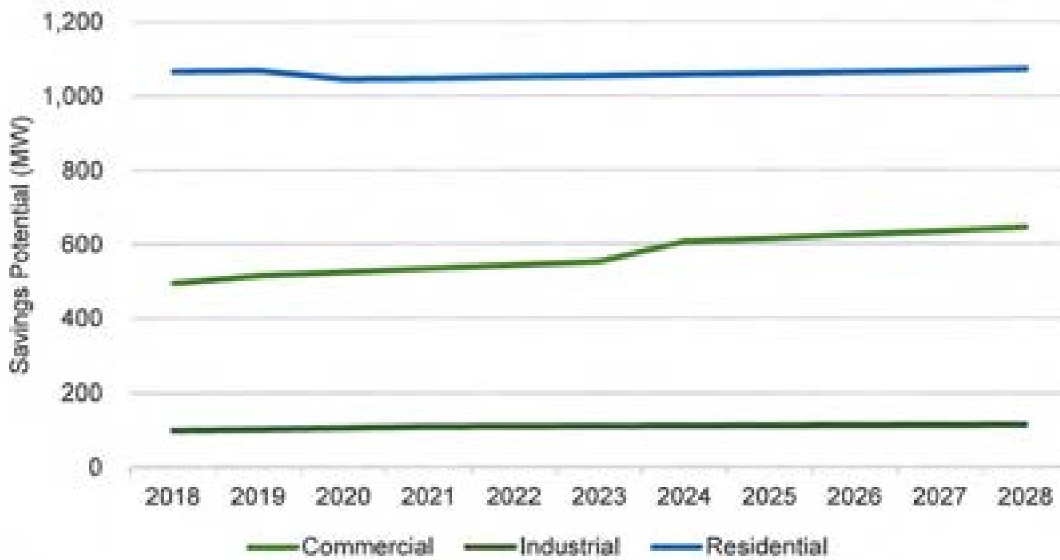
Figure 11, Figure 12, and Figure 13 show the total technical savings potential split by sector for electric energy, electric demand, and gas respectively, while Appendix G provides the associated data. The allocation of technical potential among sectors is comparable with the allocation of forecasted sales among sectors, with residential and commercial sectors contributing the greatest electric technical potential and residential contributing the greatest gas technical potential. Technical potential grows over time due to new stock additions to the territory. The drop in residential technical potential beginning around 2019 is due to changes in the federal standards for general service lighting, as discussed more in Section 5.3.4. The decreased growth rate in the commercial sector at the same time also stems largely from the general service lighting standard changes. Specifically, the potential associated with screw-in LEDs and CFLs is decreased significantly after the implementation of the standard. Comparing electric energy with electric demand, it is clear that technical residential demand savings is much higher than energy savings relative to the commercial sector. This is in large part due to non-economic measures such as the CAC Replacement, which do not pass the mTRC test and have high demand savings potential. As previously noted, all savings reported in this study are net, meaning that the effect of possible free ridership is included in the reported savings.

Figure 11. Electric Technical Savings Potential by Sector (GWh/year)



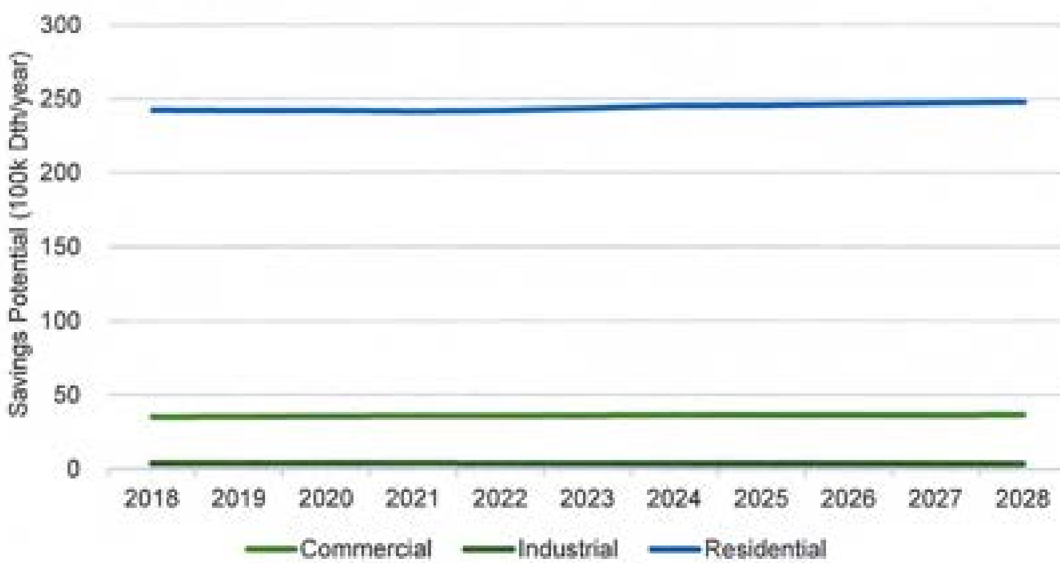
Source: Navigant 2016.

Figure 12. Electric Demand Technical Potential by Sector (MW)



Source: Navigant 2016.

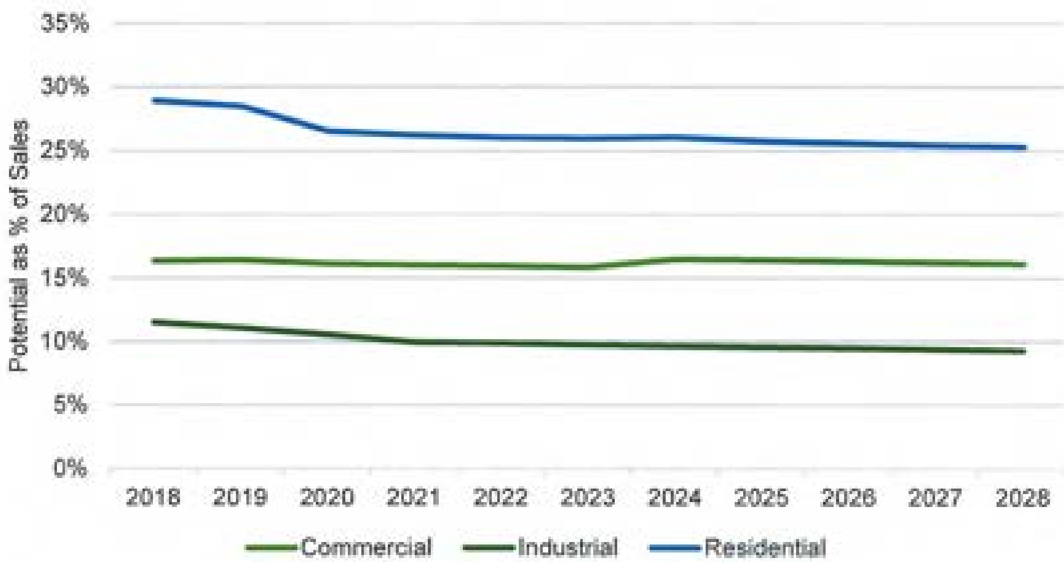
Figure 13. Gas Technical Savings Potential by Sector (100k Dth/year)



Source: Navigant 2016.

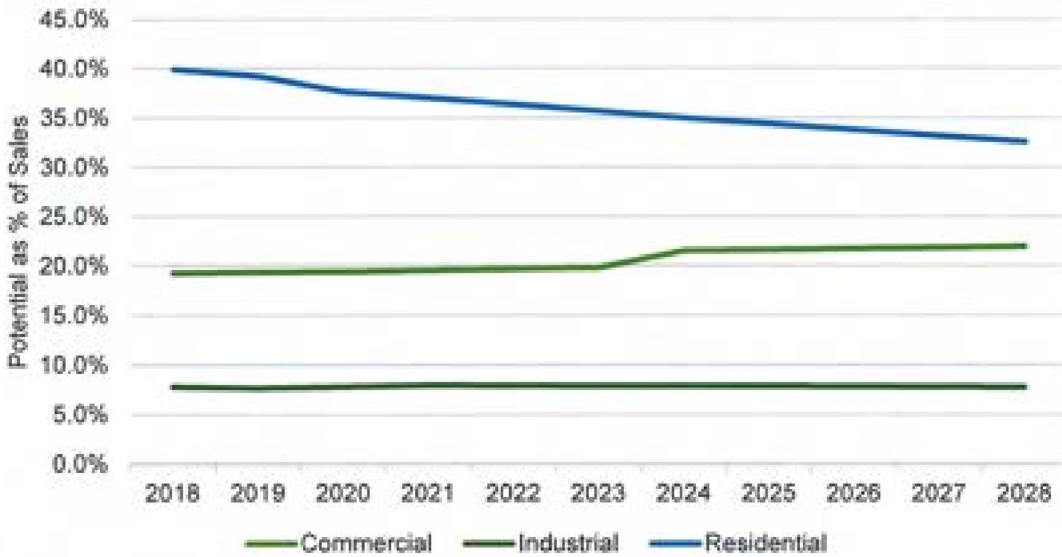
Figure 14, Figure 15, and Figure 16 show the electric and gas technical savings potential for all sectors as a percentage of that sector's total forecasted consumption, and Appendix G provides the associated data. The percentages reflect a weighted average savings among measures applicable to existing building stock and new building stock constructed during the study period. As such, the downward-sloping residential electric sector indicates that electric savings opportunities—on a percentage of consumption basis—are larger in existing construction than new construction. This perspective shows that the residential sector has the greatest technical potential as a percentage of sales for both electric and gas. Additionally, the commercial sector's electric savings as a percentage of sales stays roughly the same for over time due to the changing mix of new and existing building stock, even though the technical potential grows in absolute terms.

Figure 14. Electric Technical Savings Potential by Sector as a Percent of Sector Consumption (%)



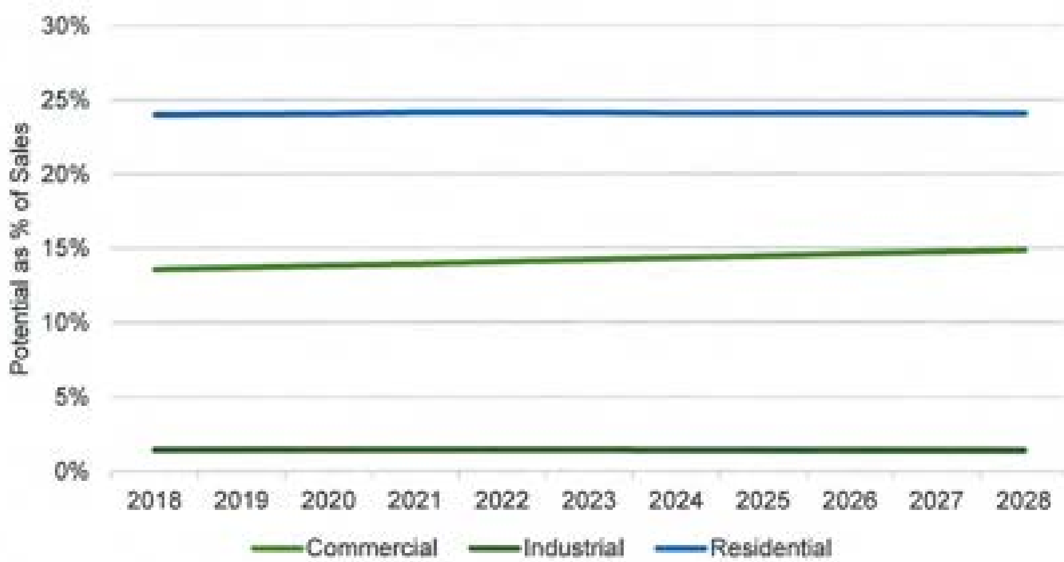
Source: Navigant 2016.

Figure 15. Electric Demand Technical Potential by Sector as a Percent of Total Sales (%)



Source: Navigant 2016.

Figure 16. Gas Technical Savings Potential by Sector as a Percent of Sector Consumption (%)

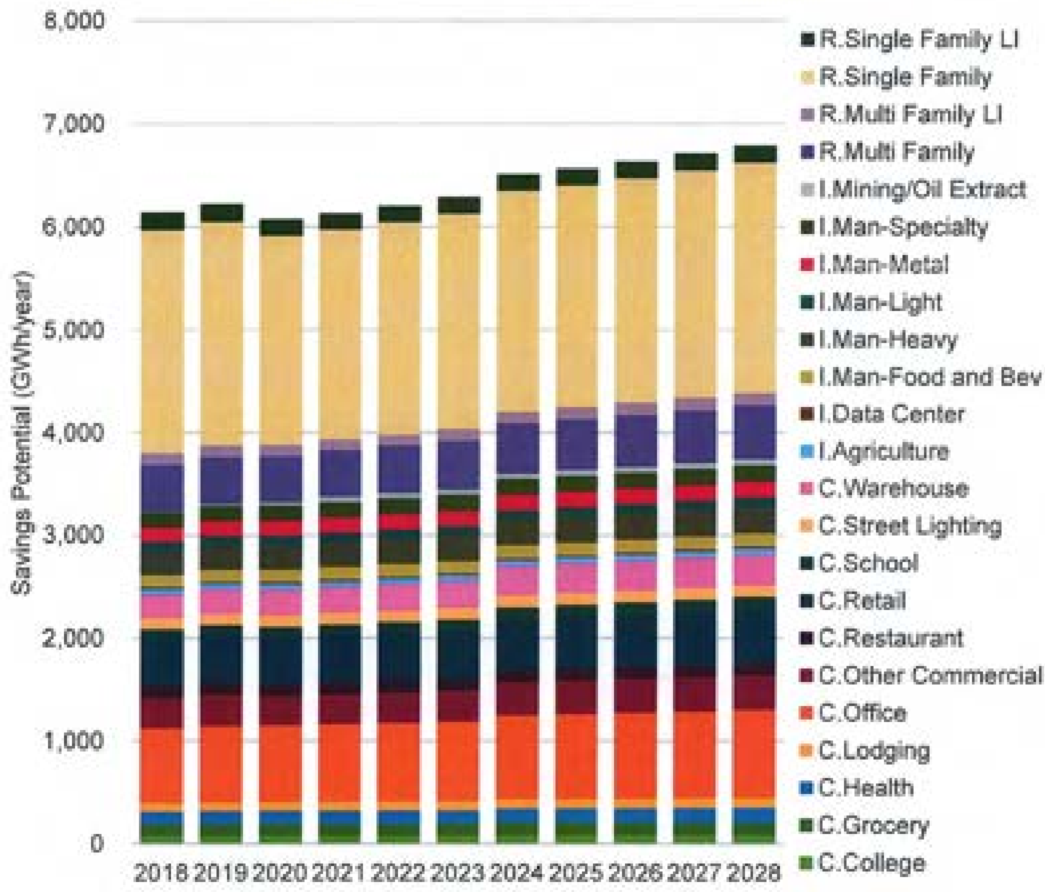


Source: Navigant 2016

3.2.2 Results by Customer Segment

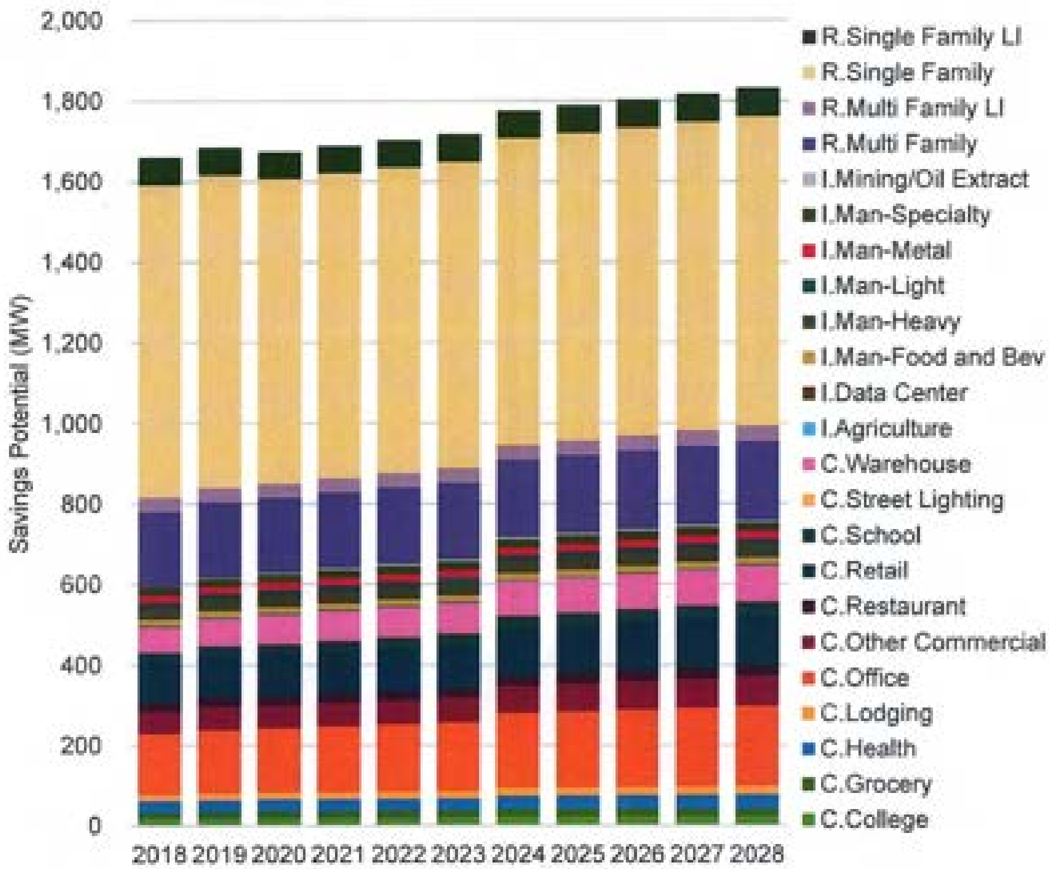
The electric energy, electric demand, and gas technical potentials shown in Figure 17, Figure 18, and Figure 19, respectively, are broken out for each of the customer segments, and Appendix G provides the associated data. These figures highlight the large savings potential of the residential single-family home customer segment relative to other customer segments. The growth in potential for the single-family home segment is the largest contributor to the increase in technical savings potential. On the commercial side, while technical savings is more evenly split, the office and retail segments stand out as large opportunities, driven by LEDs, and efficient building new construction.

Figure 17. Electric Technical Savings Potential by Customer Segment (GWh/year)



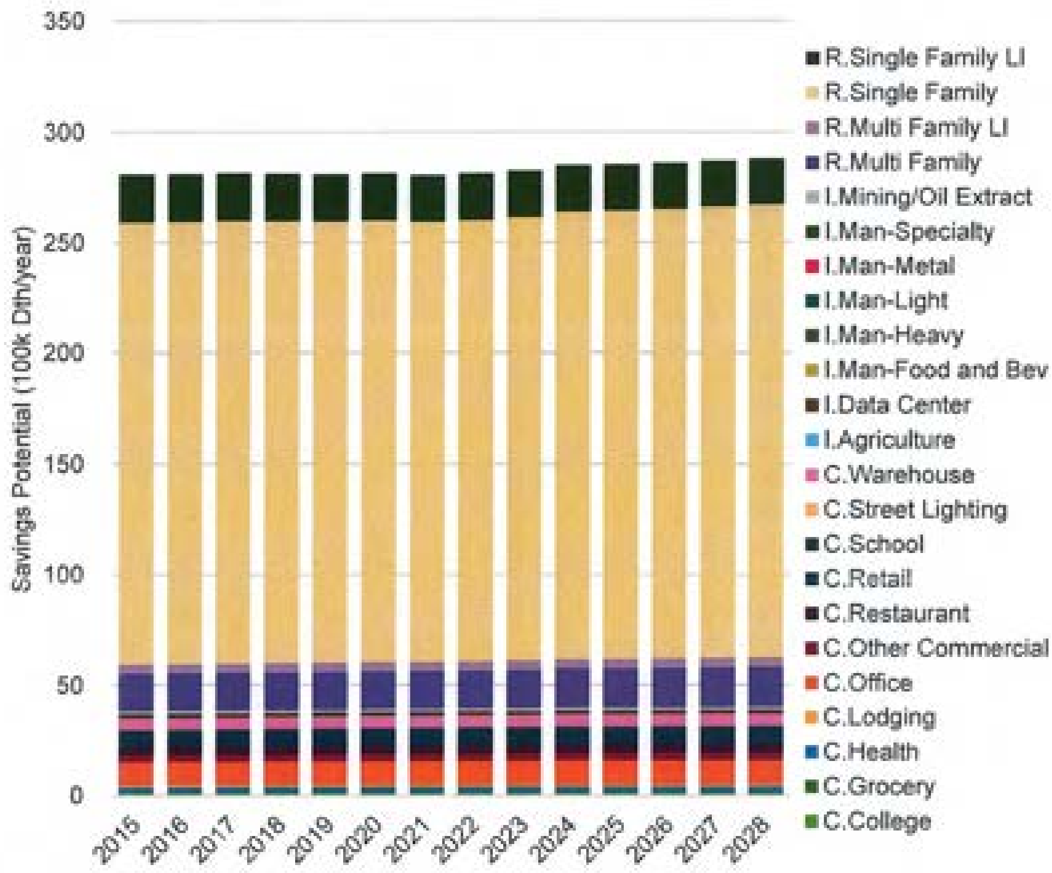
Source: Navigant 2016.

Figure 18. Electric Demand Technical Potential by Customer Segment (MW)



Source: Navigant 2016.

Figure 19. Gas Technical Savings Potential by Customer Segment (100k Dth/year)



Source: Navigant 2016.

3.2.3 Results by Measure

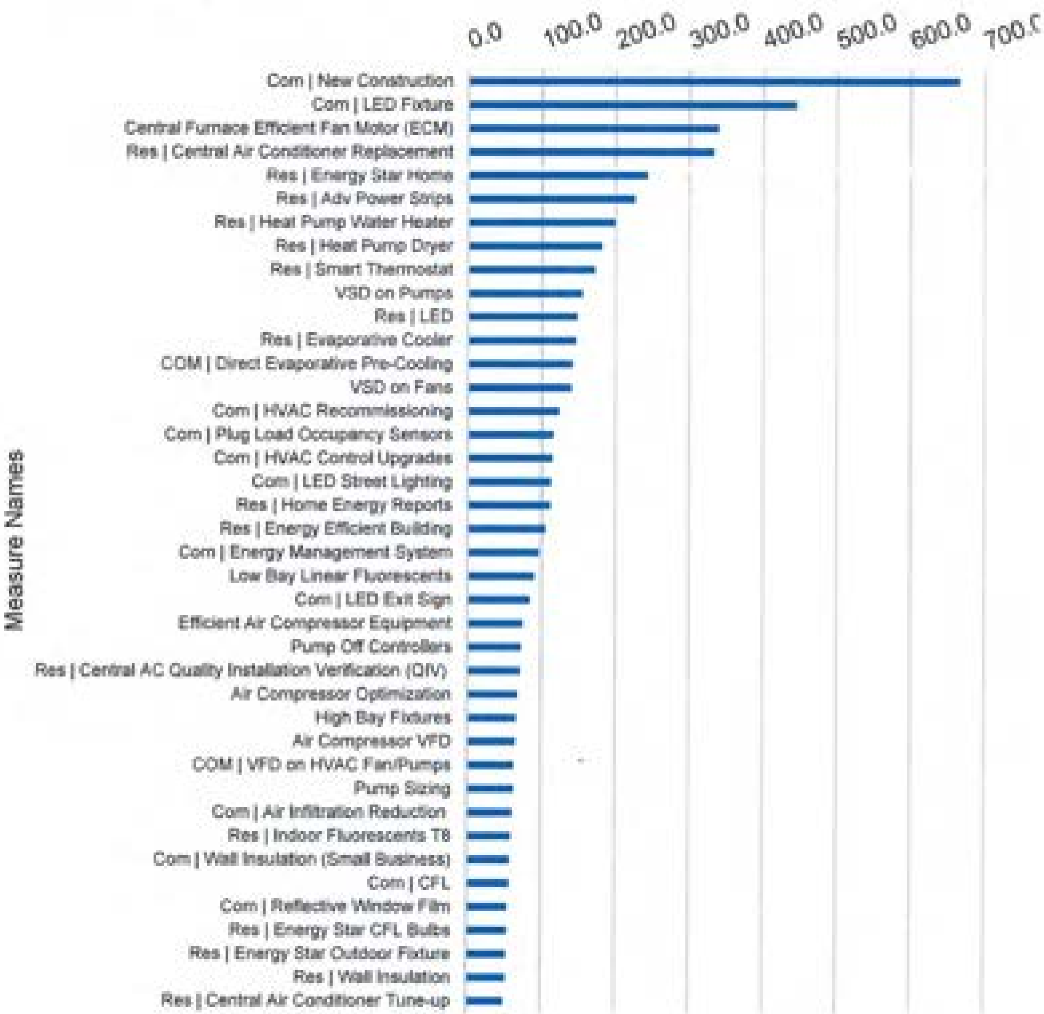
The measure-level savings potential shown in Figure 20, Figure 21, and Figure 22 is after adjustments made due to competition groups. This is consistent with the aggregate results shown above. However, it should be noted that for the achievable potential scenarios, measures gain market share relative to their economic characteristics rather than their savings potential alone, thus measures will be included in the achievable potential forecast that are not shown in this section.

These figures present the top forty measures ranked by their technical savings potential in 2025. Wherever a group of measures were similar in nature, Navigant consolidated their potential into a representative measure name to produce a more succinct view at the measure level. For example, the energy management potential in the figure represents the technical savings potential for industrial energy management and commercial energy management, which encompass energy savings opportunities unique to each sector.

When code-change measures become applicable, they "steal" savings potential from other related measures that may display significant savings in absence of the code. In this way, the sum of the total savings potential between the code and the related energy-efficient measure is the same before and after a code takes effect. This ensures there is no double counting of savings from codes and the energy efficient measures impacted by the code.

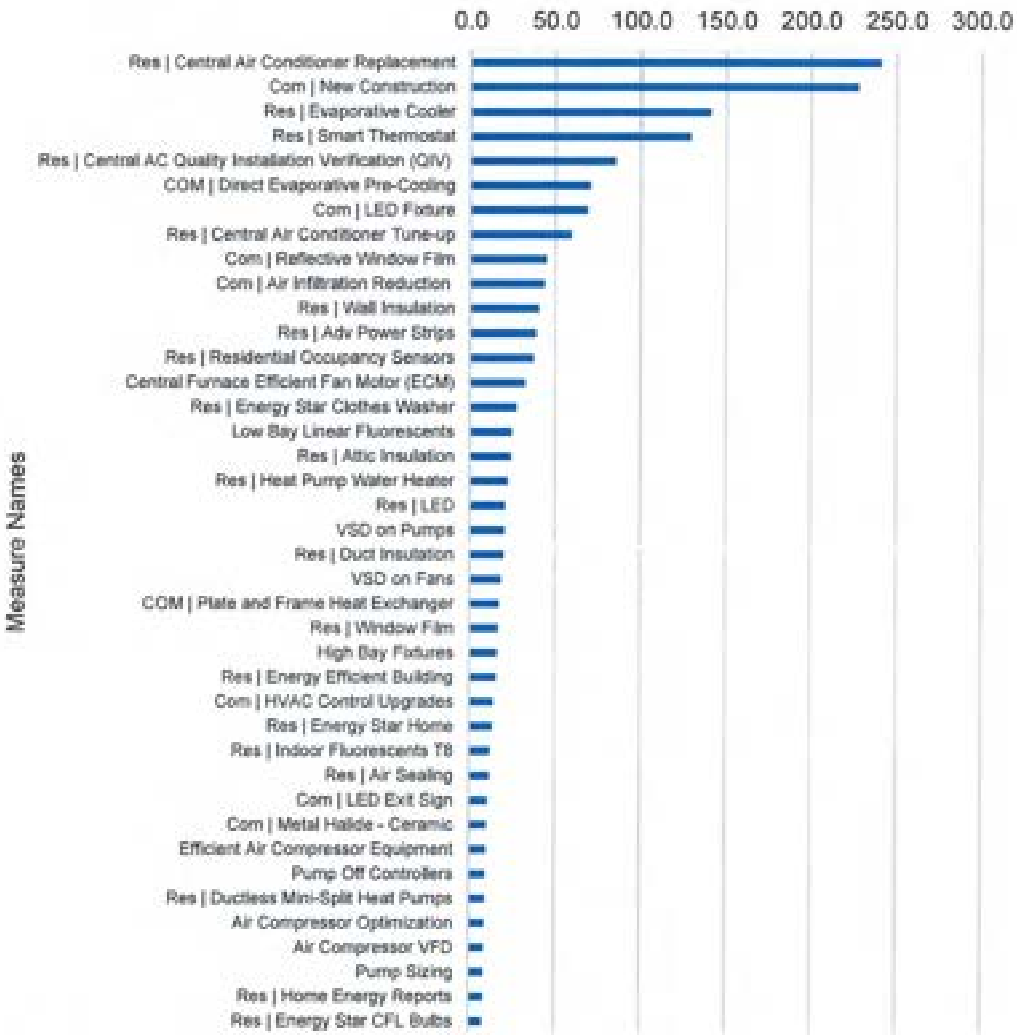
The top five measures for electric energy technical potential come from lighting, whole building, space heating, and space cooling end uses Measures such as new construction (25 percent) in the commercial sector are not show in this graph, as they have lower potential than another measure in the same competition group (new construction (40 percent), and as detailed above, technical potential assumes that the each installation is completed with the measure with the highest technical potential. Several measures, such as residential LEDs, that have the highest technical potential are out competed in the achievable potential scenario due to lower cost effectiveness from a consumer's perspective.

Figure 20. Top 40 Measures for Electric Technical Savings Potential in 2025 (GWh/year)



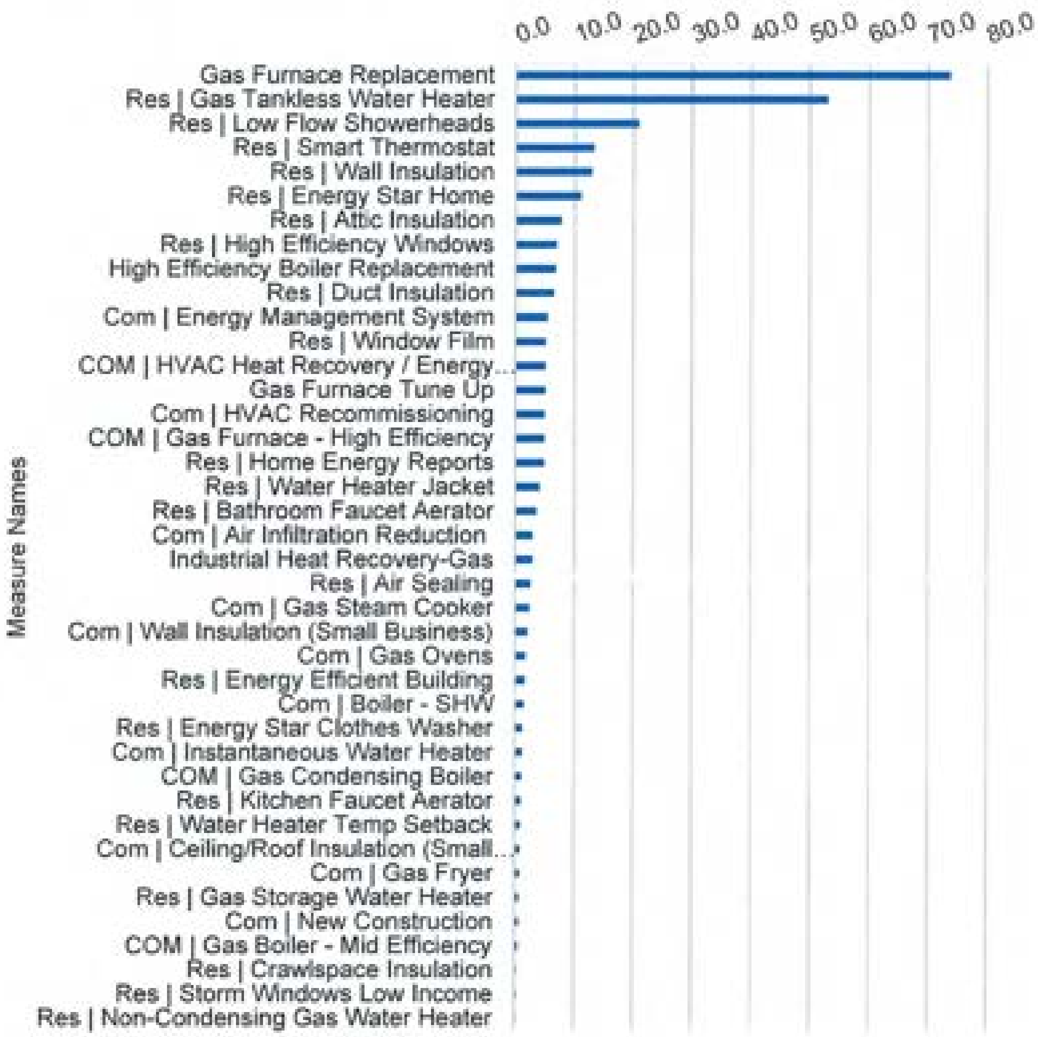
Source: Navigant 2016.

Figure 21. Top 40 Measures for Electric Technical Demand Potential in 2025 (MW)



Source: Navigant 2016.

Figure 22. Top 40 Measures for Gas Technical Savings Potential in 2025 (100k Dth/year)



Source: Navigant 2016.

4. ECONOMIC POTENTIAL FORECAST

This section describes the economic savings potential, which is potential that meets a prescribed level of cost effectiveness, available in Xcel Energy's Colorado service territory. The section begins by explaining Navigant's approach to calculating economic potential. It then presents the results for economic potential.

4.1 Approach to Estimating Economic Potential

Economic potential is a subset of technical potential, using the same assumptions regarding immediate replacement as in technical potential, but including only those measures that have passed the benefit-cost test chosen for measure screening (in this case the modified Total Resource Cost (mTRC) test,[26] per Xcel Energy's guidance). The mTRC ratio for each measure is calculated each year and compared against the measure-level mTRC ratio screening threshold of 1.0. A measure with an mTRC ratio greater than or equal to 1.0 is a measure that provides monetary benefits greater than or equal to its costs. If a measure's mTRC meets or exceeds the threshold, it is included in the economic potential.

The mTRC test is a cost-benefit metric that measures the net benefits of energy efficiency measures from combined stakeholder viewpoint of the utility (or program administrator) and the customers. The model calculates the mTRC benefit-cost ratio using the following equation:

Equation 4. Benefit-Cost Ratio for Modified Total Resource Cost Test

$$mTRC = \frac{PV(Avoided\ Costs + O\&M\ Savings)}{PV(Technology\ Cost + Admin\ Costs)}$$

Where:

- *PV( )* is the present value calculation that discounts cost streams over time;
- *Avoided Costs* are the monetary benefits resulting from gas and electric savings (e.g., avoided costs of infrastructure investments, avoided commodity costs due to gas and/or electric energy conserved by efficient measures), and non-energy benefits (NEBs), quantified through an adder on the avoided costs;
- *O&M Savings* are the non-energy benefits such as operation and maintenance cost savings;
- *Technology Cost* is the incremental equipment cost to the customer;
- *Admin Costs* are the administrative costs incurred by the utility or program administrator.

[26] The mTRC test is the same as the TRC test in Colorado, with the exception that the avoided costs include a non-energy benefits adder, which differs for low income and non-low income customers.

Navigant calculated mTRC ratios for each measure based on the present value of benefits and costs (as defined above) over each measure's life.[27] Appendix E.2 provides information on measure-specific cost inputs.

As agreed upon with Xcel Energy, Navigant applied net-to-gross (NTG) factors to savings at the measure level throughout, accounting for free ridership and making the results presented in this study *net* rather than *gross* savings.[28]

Although the mTRC equation includes administrative costs, the study does not consider these costs during the measure-level economic screening process because an individual measure's cost effectiveness "on the margin" is the primary focus. Navigant also excluded measure-level administrative costs from this analysis because those costs are largely driven by program design, which is outside of the scope of this evaluation. Program and portfolio administrative costs, estimated from Xcel Energy's historic administrative costs, were included in program and portfolio budgets to provide a more accurate picture of expected total portfolio spending. These administrative spending levels were held constant over time and across all scenarios.

Similar to technical potential, only one "economic" measure (meaning that its mTRC ratio meets the threshold) from each competition group is included in the summation of economic potential across measures (e.g., at the end-use category, customer segment, sector, service territory or portfolio level). If a competition group is composed of more than one measure that passes the mTRC test, then the economic measure that provides the greatest savings potential is included in the summation of economic potential. This approach ensures that double counting is not present in the reported economic potential, though economic potential for each individual measure is still calculated and reported outside of the summation.

4.2 Economic Potential Results

This section provides DSMSim™ results pertaining to electric and natural gas economic savings potential at different forms of aggregation. Results are shown by sector, customer segment, and highest-impact measures.

4.2.1 Results by Sector

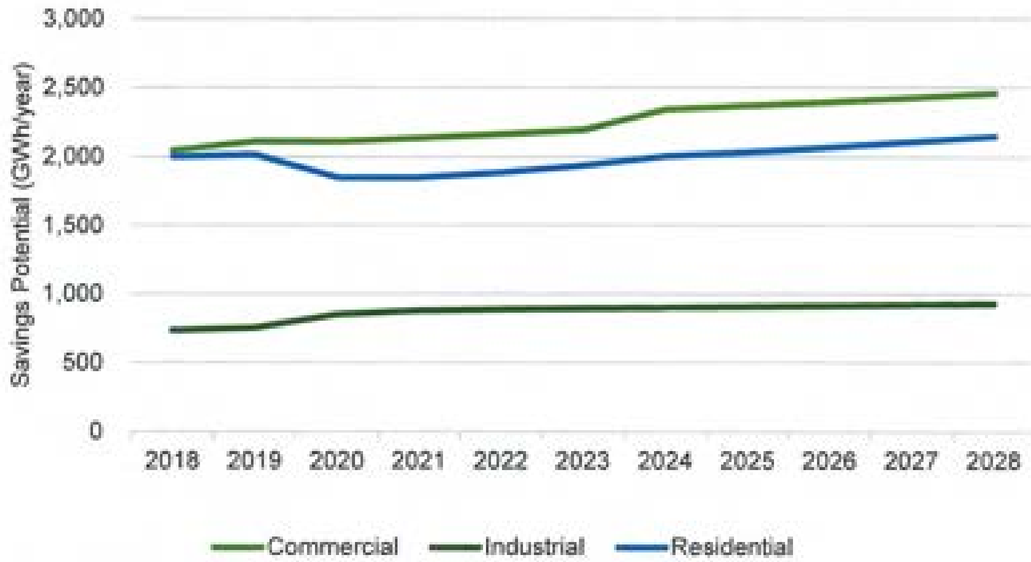
Figure 23, Figure 24, and Figure 25 show economic electric energy, electric demand, and gas savings potential across all sectors, respectively. The data used to generate these figures are in Appendix G. On average across the study period, 79 percent of electric energy savings, 63 percent of electric demand savings, and 54 percent of gas energy savings potential pass the economic screening process. In contrast to technical potential, the residential economic potential is less than the commercial economic potential. This is due to the larger impact of federal lighting standards on the residential sector, as well as a larger number of measures with high technical potential, such as central air conditioner replacements, and heat pump dryers, failing the mTRC screen. Both commercial and residential economic potential show a marked increase in 2024 due to the large projected spike in the sector gas sales in this period,

[27] Navigant used discount rates of 6.78 percent for electric only and electric/gas measures and 6.59 percent for gas only measures.

[28] Navigant used NTG values from Xcel Energy program data, where available. Where this data was not available, Navigant used a NTG of 1.0.

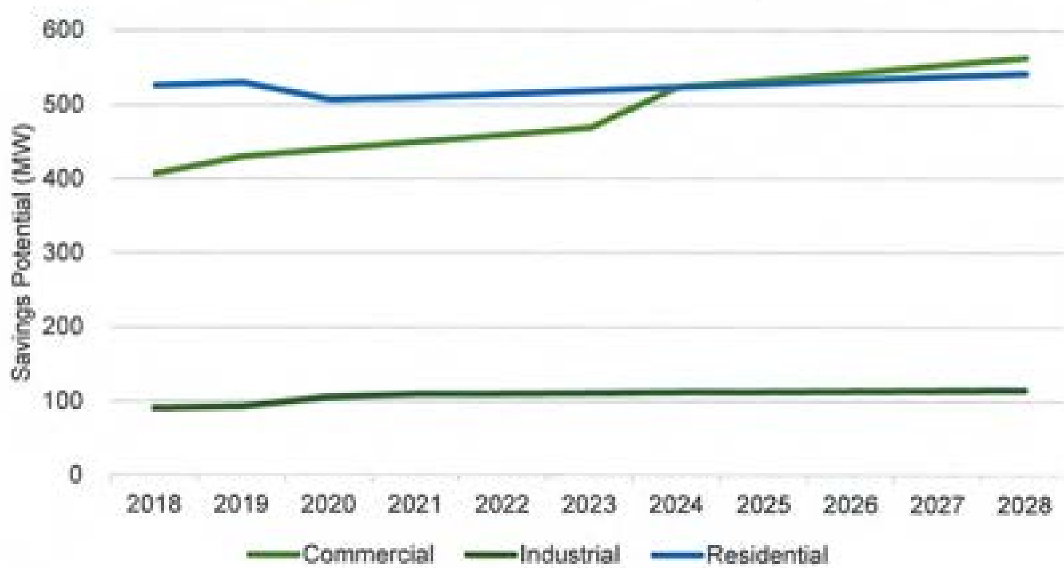
which is passed through to the available stock. Because this stock comes online as new growth, this is captured primarily in new construction measures.

Figure 23. Electric Energy Economic Potential by Sector (GWh/year)



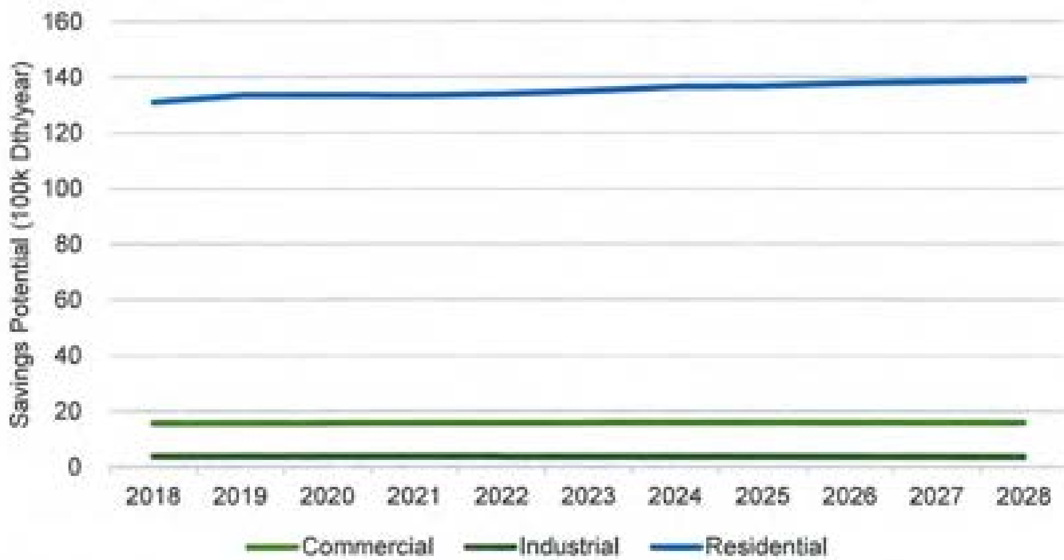
Source: Navigant 2016.

Figure 24. Electric Demand Economic Potential by Sector (MW)



Source: Navigant 2016.

Figure 25. Gas Energy Economic Potential by Sector (100k Dth/year)



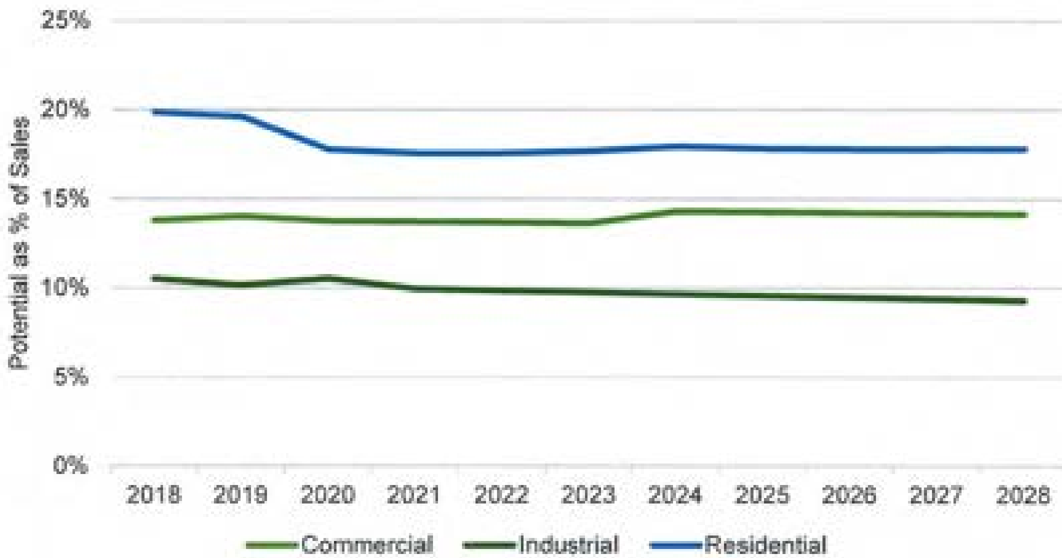
Source: Navigant 2016.

Other bumps in select years of the economic potential, particularly visible for electric energy and electric demand, occur whenever one or more measures cross the cost-effectiveness threshold in one or more customer segments. Marginally economic measures having mTRC ratios slightly less than 1.0 at the beginning of the study period can become economically feasible as avoided costs—which escalate at a faster rate than equipment and operation and maintenance costs—increase throughout the study the period. For example, in the industrial sector, the bump up in 2020 is caused by air compressor VFDs screening for the first time. A small increase in commercial potential occurs in 2019 when vending machine occupancy sensors become cost effective. In the residential sector, two marginal measures become cost effective during the forecast period: water heater jackets in 2019 and central high efficiency boilers in 2024.

Technical and economic energy potential are similar in the industrial sector because the measures included in the study are selected on the premise that they are currently or could become reasonably attractive to industrial customers and have some likelihood of adoption given a wide range of market environments. Considering many industrial customers purchase electricity and gas at rates lower than other customers, market experience has shown industrial customers require measures to be more economic than residential and commercial customers do. Thus, the measures deemed reasonably attractive to industrial customers tend to fair very well in an mTRC ratio using the utility's avoided costs, which are often higher than industrial retail rates.

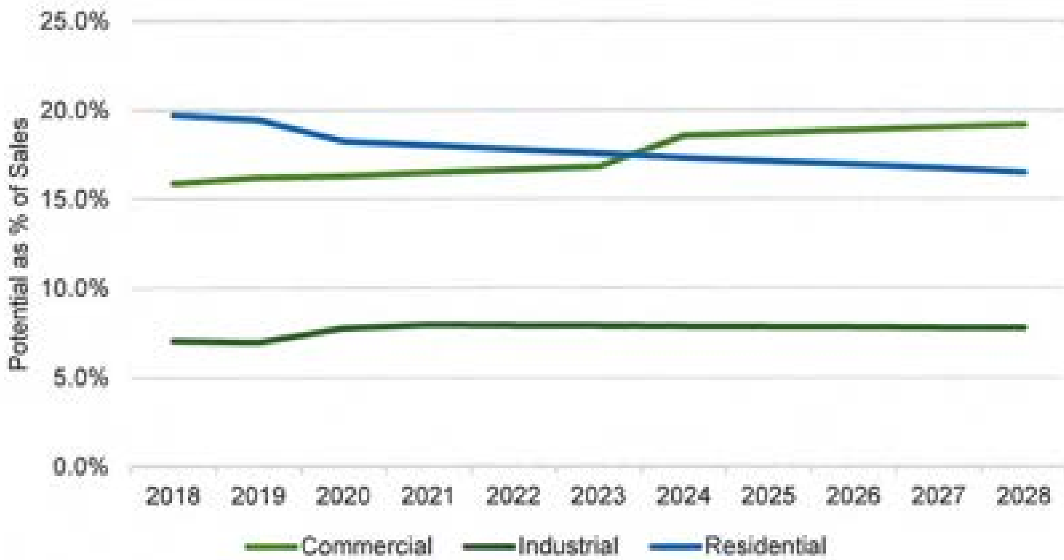
Figure 26, Figure 27, and Figure 28 show the economic electric energy, electric demand, and gas savings potential as a percentage of consumption or demand, respectively, with associated data presented in Appendix G. The most noteworthy trend in economic potential as a percent of sales is that, like technical potential as a percent of sales, it is flat or gradually decreasing over time. This occurs as the growth in consumption outpaces the growth of potential. There are some exceptions to this pattern, such as commercial electric demand potential, where there relative contribution of new construction measures is greater and contributes to a general upward trend.

Figure 26. Electric Energy Economic Potential by Sector as a Percent of Total Sales (%)



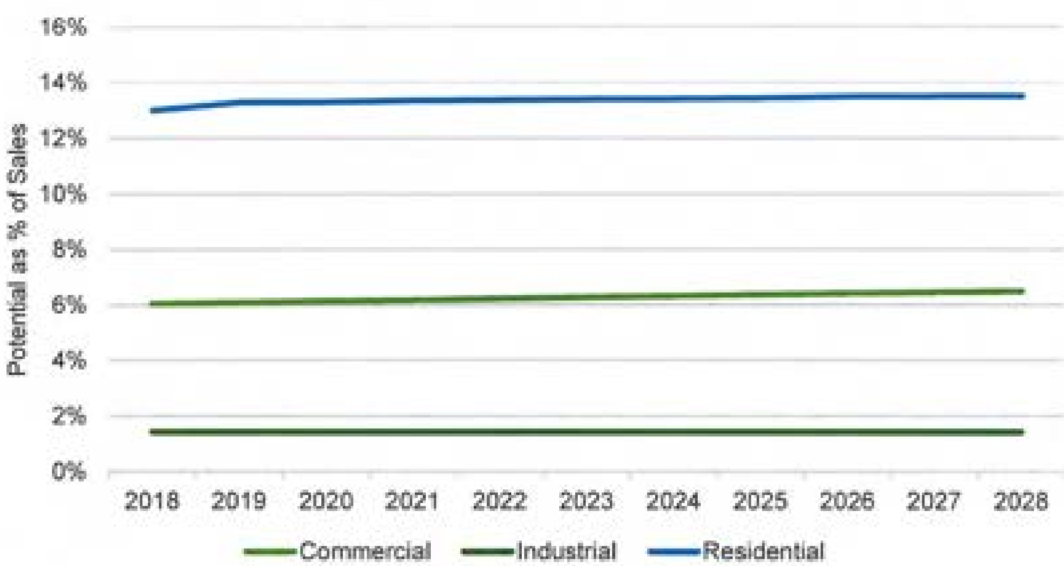
Source: Navigant 2016.

Figure 27. Electric Demand Economic Potential by Sector as a Percent of Total Sales (%)



Source: Navigant 2016.

Figure 28. Gas Energy Economic Potential by Sector as a Percent of Total Sales (%)



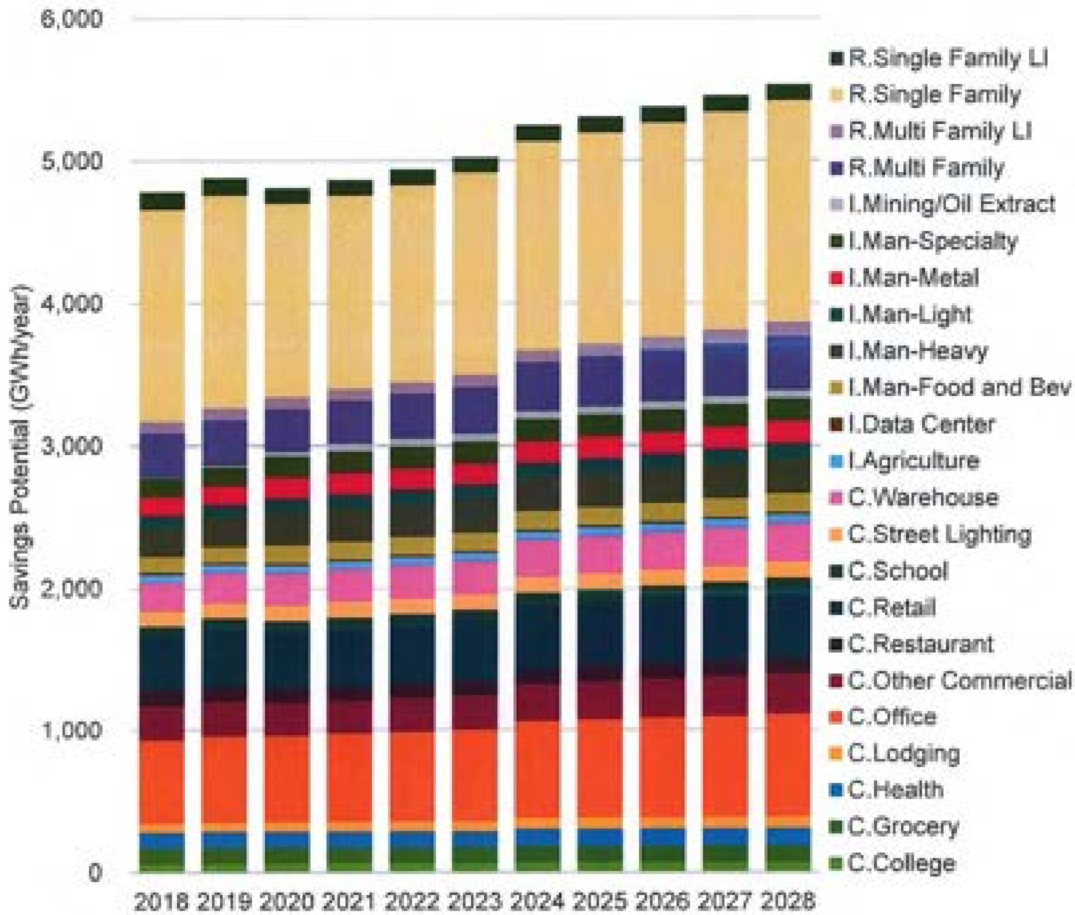
Source: Navigant 2016.

4.2.2 Results by Customer Segment

Figure 29, Figure 30, and Figure 31 depict the economic electric energy, electric demand, and gas savings potential for all customer segments, and Appendix G provides the corresponding data values. Depending on the customer segment, between 68 percent and 77 percent of the technical electric energy potential passes the economic screening threshold within the residential sector. The greatest reduction from technical potential appeared in single-family homes, while the smallest reduction occurs in multi-family low income homes. For the commercial customer segments, the percentage of technical electric energy potential that passes the economic screen ranges from 83 percent to 99 percent. Offices see the greatest loss from non-economic potential, while the street lighting segment is the most resilient. Industrial measures pass the economic screen for the most part. The segment that saw the greatest losses was specialty manufacturing, which saw a reduction in potential of just over 2 percent from technical to economic.

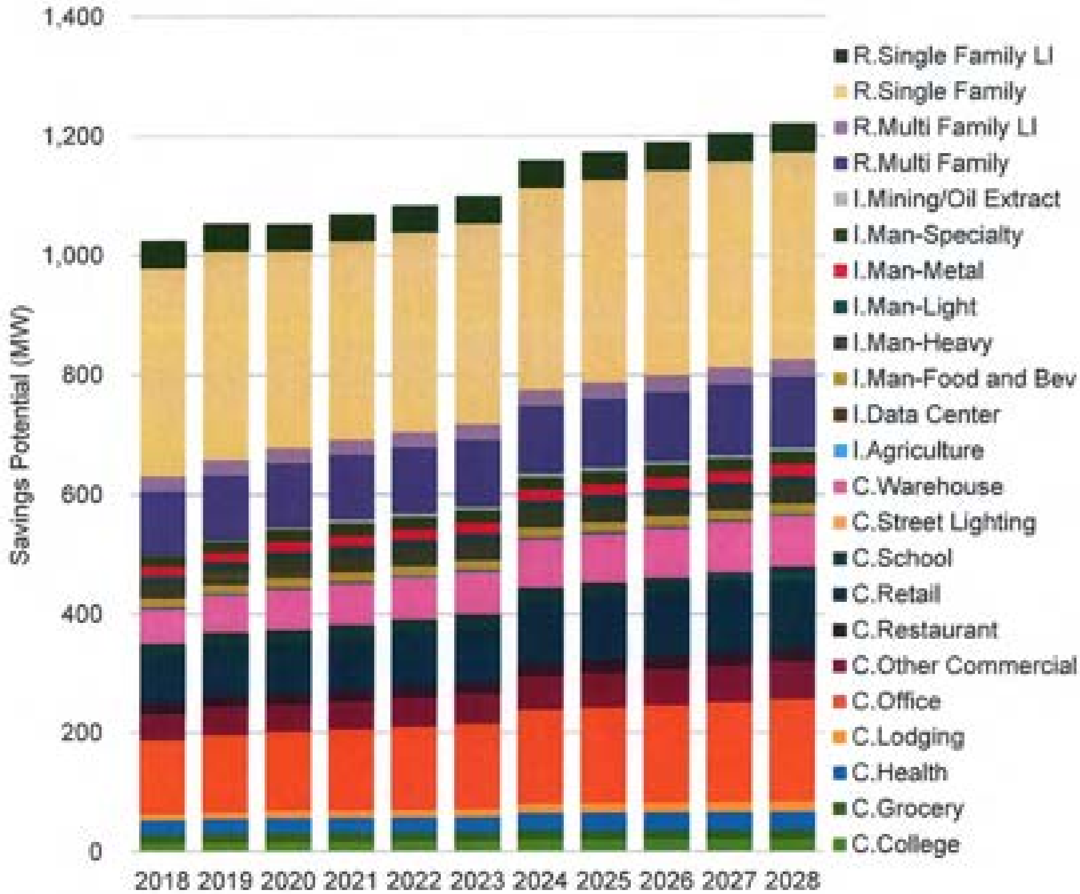
In general, the mix of economic energy savings from various customer segments within a given sector is similar between economic and technical potential. Single-family homes have the highest occurrence of economic savings, and they provide the largest share of economic savings potential within the residential sector. The mix of economic potential from the commercial and industrial segments does not change appreciably relative to the technical potential.

Figure 29. Electric Energy Economic Potential by Customer Segment (GWh/year)



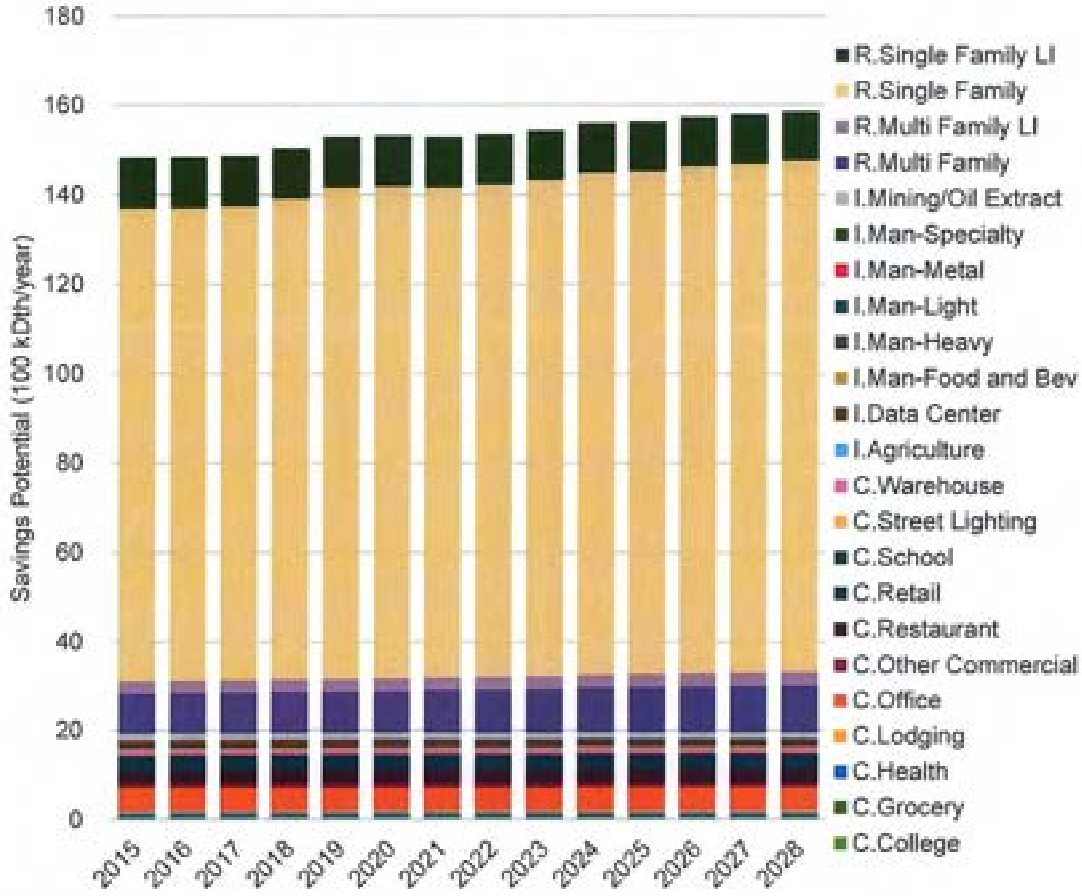
Source: Navigant 2016.

Figure 30. Electric Demand Economic Potential by Customer Segment (MW)



Source: Navigant 2016.

Figure 31. Gas Energy Economic Potential by Customer Segment (100k Dth/year)



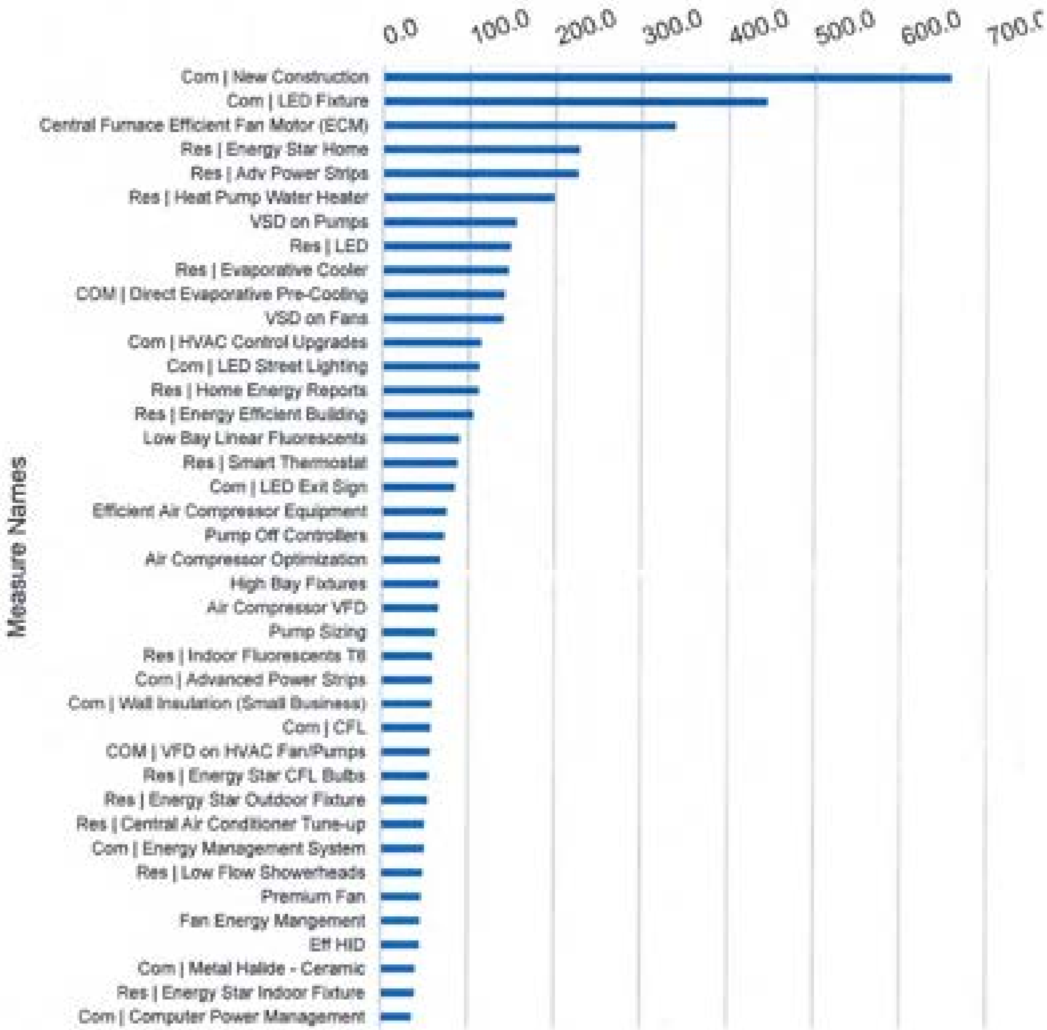
Source: Navigant 2016.

4.2.3 Results by Measure

The measure-level economic electric energy, electric demand, and gas savings potential shown in Figure 32, Figure 33, and Figure 34 are prior to adjustments made to competition groups as detailed in Section 3.1.3. These figures highlight the economic potential from the top 40 highest-impact measures. When compared with electric energy technical potential, both the fourth measure (central air conditioner replacement) and the eighth measure (heat pump dryer) screen out as non-cost effective. The residential smart thermostat drops from ninth to seventeenth. With respect to electric demand potential, commercial LEDs rise from the seventh to the fourth position due to multiple residential measures failing to screen.

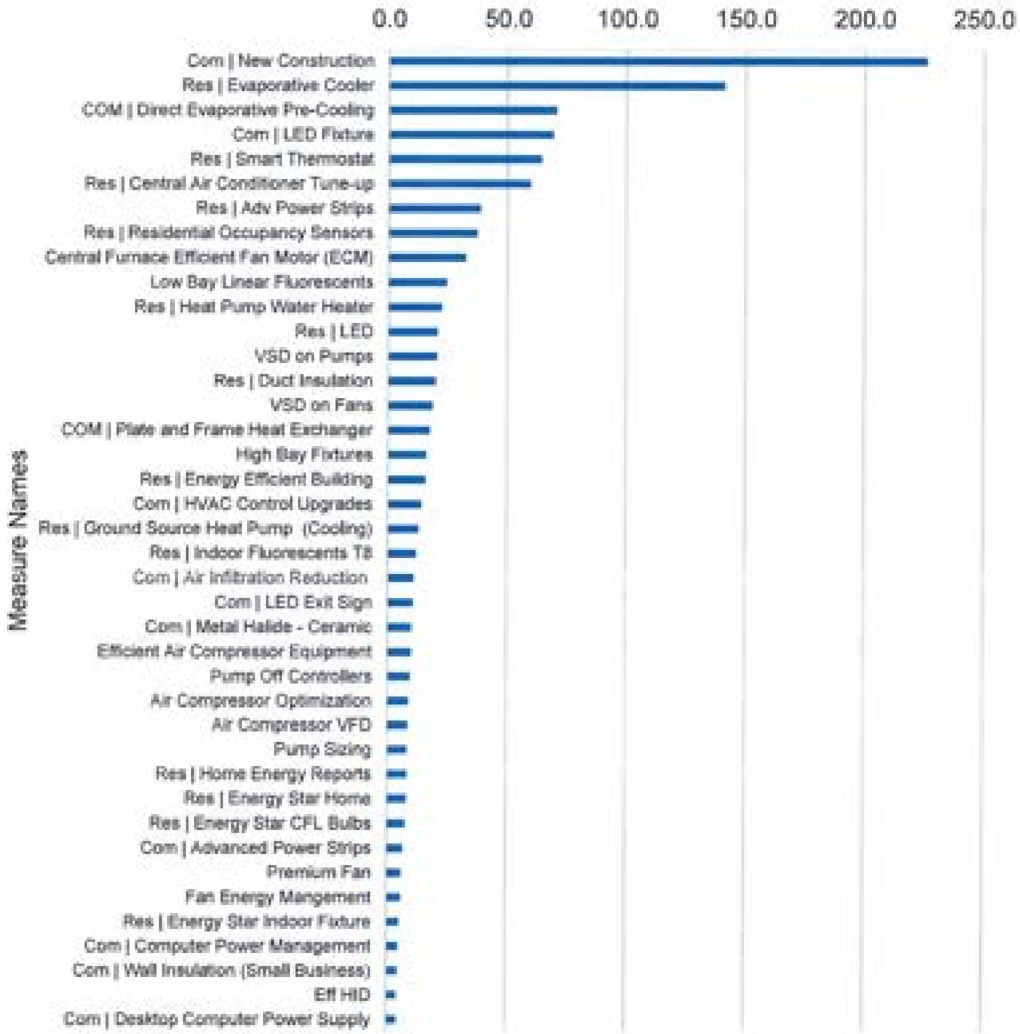
For gas economic potential, the second measure in technical potential, gas tankless water heaters, screens out as non-cost effective. Residential wall insulation drops from the fifth to the thirty-second position. High efficiency boiler replacements rise to the fourth from the ninth position overall.

Figure 32. Top 40 Measures for Electric Energy Economic Potential in 2025 (GWh/year)



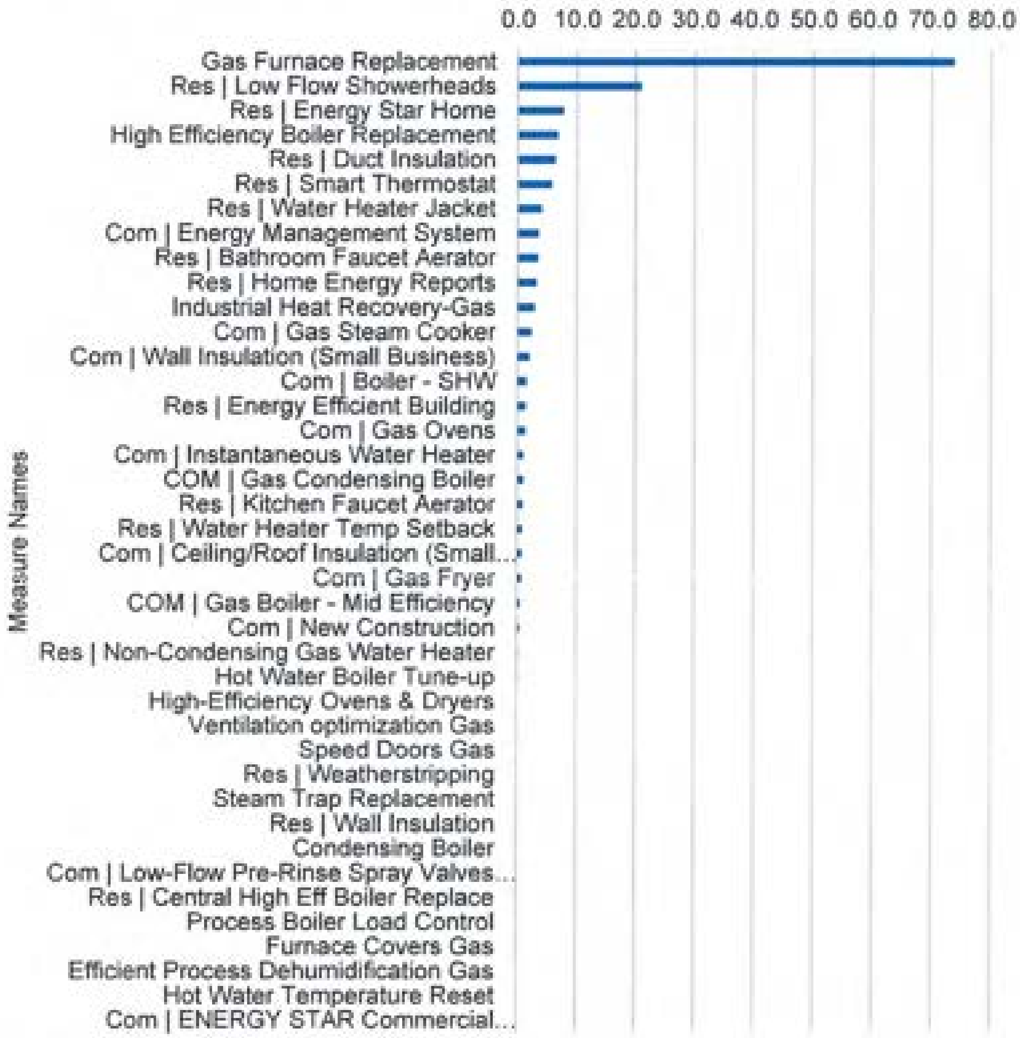
Source: Navigant 2016.

Figure 33. Top 40 Measures for Electric Demand Economic Potential in 2025 (MW)



Source: Navigant 2016.

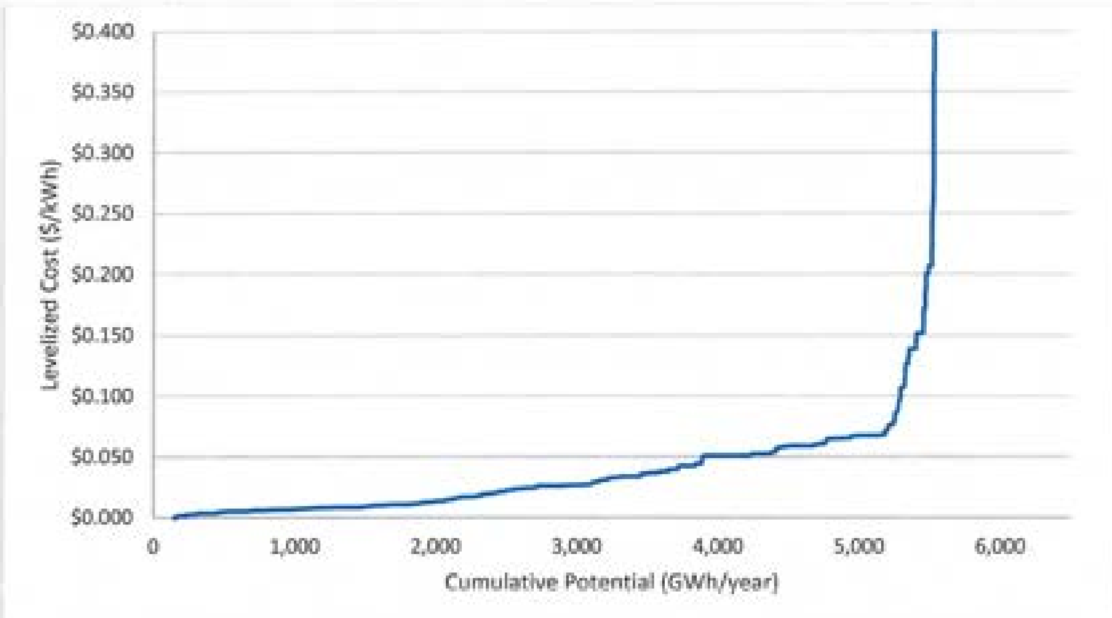
Figure 34. Top 40 Measures for Gas Energy Economic Potential in 2025 (100k Dth/year)



Source: Navigant 2016.

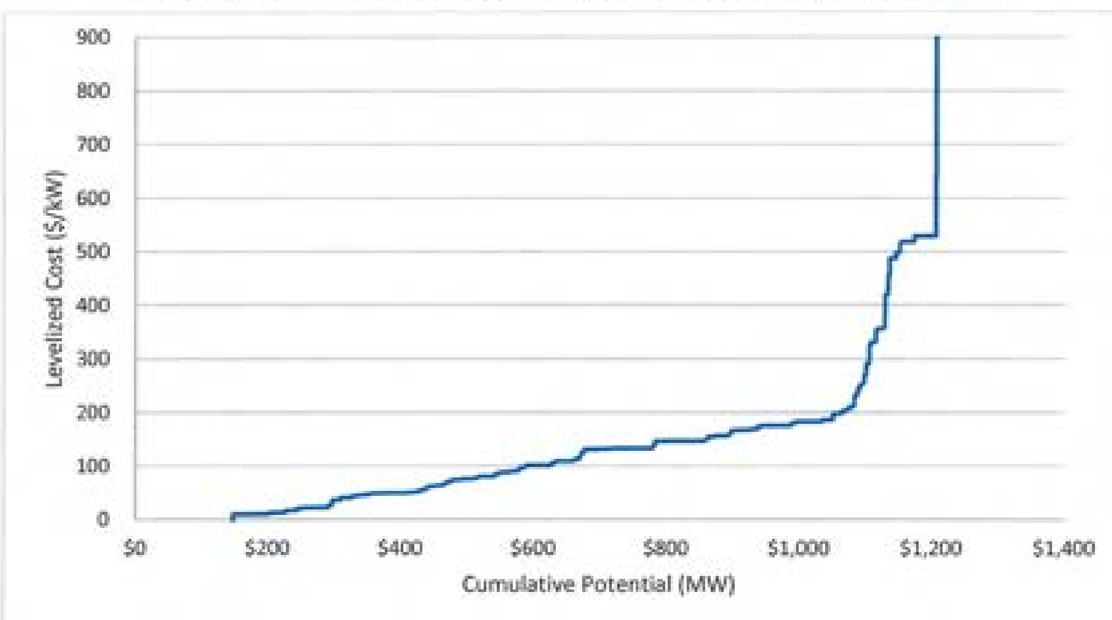
Figure 35, Figure 36, and Figure 37 provide a supply curve of savings potential versus levelized cost of savings for all measures considered in the study. To show the most relevant measures and improve readability, these curves have been truncated somewhat to show only those measures with a levelized cost below a certain threshold—the full curve would extend beyond this to measures with more costly savings. For electric energy, the vast majority of savings occurs at a levelized cost between $0.001 and $0.05/kWh. The majority of electric demand savings occurs at a levelized cost between $10 and $150/kW. For gas savings, most economic potential occurs at a levelized cost between $0.05 and $0.5/Dth.

Figure 35. Electric Energy Economic Potential LCOE Supply Curve in 2028



Source: Navigant 2016.

Figure 36. Electric Demand Economic Potential LCOE Supply Curve in 2028



Source: Navigant 2016.

Figure 37. Gas Energy Economic Potential LCOE Supply Curve in 2028

Source: Navigant 2016.

5. ACHIEVABLE POTENTIAL FORECAST

This section contains details of the achievable potential analysis conducted by Navigant. It is important to note that any forecast of DSM potential will always imply a certain degree of uncertainty. To fully represent the variation of potential that reflects the range of uncertainty, we modeled various scenarios: a Reference scenario (i.e., that best reflects the presumed mid-point of the uncertainty), a Max Utility Benefits scenario, a Low Utility Benefits scenario, and an Alternative Lighting scenario. Results from each scenario will be reported in this chapter.

Section 5.1 describes the approach to estimating achievable potential, including discussion of the various incentive approaches that were tested, the different scenarios, and finally the model calibration steps. Next, Section 5.2 provides achievable electric and gas savings estimates by sector, customer segment, end use, and measures for the Reference Scenario, as well as the associated supply curves and budgets. Section 5.3 follows with details of the estimated savings and associated budgets for the three other scenarios: Max Utility Benefits, Low Utility Benefits, and Alternative Lighting. Section 5.4 summarizes the upstream market actor surveys. Finally, Section 5.5 reports on the results of the benchmarking analysis.

5.1 Approach to Estimating Achievable Potential

This section provides a high-level summary of the approach to calculating achievable potential, which is fundamentally more complex than calculation of technical or economic potential. The adoption of DSM measures can be broken down into calculation of the "equilibrium" market share and calculation of the dynamic approach to equilibrium market share.

5.1.1 Calculation of "Equilibrium" Market Share

The equilibrium market share can be thought of as the percentage of individuals choosing to purchase a technology provided those individuals are fully aware of the technology and its relative merits (e.g., the energy- and cost-saving features of the technology). For DSM measures, a key differentiating factor between the base technology and the efficient technology is the energy and cost savings associated with the efficient technology. Of course, that additional efficiency often comes at a premium in initial cost. In previous potential studies conducted by Navigant, equilibrium market share is thus often calculated as a function of the payback time of the efficient technology relative to the inefficient technology. While such approaches certainly have limitations, they are nonetheless directionally reasonable and simple enough to permit estimation of market share for the dozens or even hundreds of technologies that are often considered in potential studies.

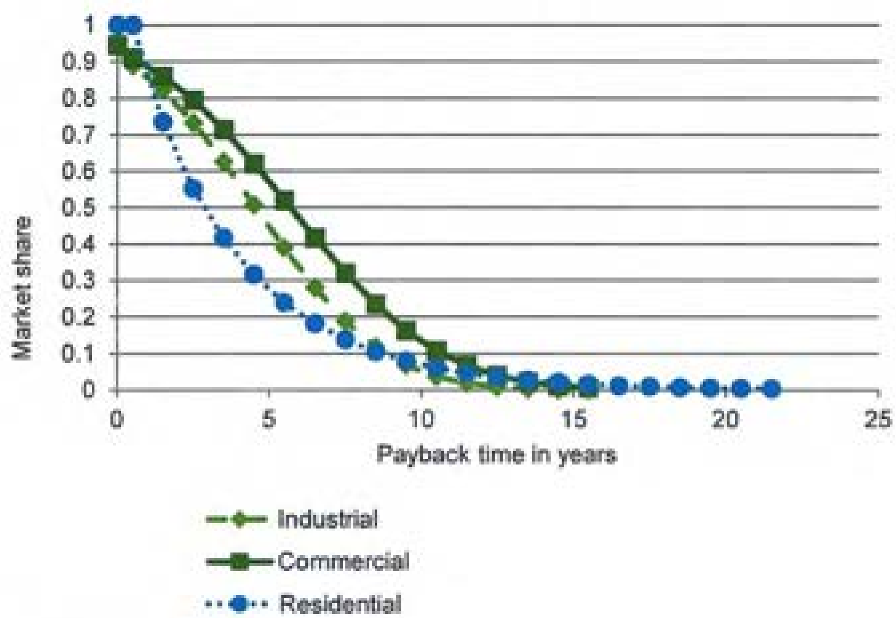
In the Xcel Energy Potential Study, Navigant used equilibrium "payback acceptance" curves that were developed using primary research conducted by Navigant in the US Midwest in 2012.[29]. To develop these curves, Navigant relied on surveys of 400 residential, 400 commercial, and 150 industrial customers. These surveys presented decision makers with numerous "choices" between technologies

[29] A detailed discussion of the methodology and findings of this research are contained in "Demand Side Resource Potential Study," prepared for Kansas City Power and Light, August 2013.

with low up-front costs, but high annual energy costs, and measures with higher up-front costs but lower annual energy costs. Statistical analysis was conducted by Navigant to develop the set of curves shown in Figure 38, which were used in this Potential Study.

As the curves show, the proportion of customers who will accept different payback periods for an energy efficiency investment is different for residential, commercial and industrial customers. The model uses this information to simulate how measures with differing payback periods will be accepted within each sector.

Figure 38. Payback Acceptance Curves



Source: Navigant 2016.

Since the payback time of a technology can change over time, as technology costs and/or energy costs change over time, the "equilibrium" market share can also change over time. The equilibrium market share is therefore recalculated for every year of the forecast to ensure the dynamics of technology adoption take this effect into consideration. As such, "equilibrium" market share is a bit of an oversimplification and a misnomer, as it can itself change over time and is therefore never truly in equilibrium, but it is used nonetheless to facilitate understanding of the approach.

5.1.2 Calculation of the Approach to Equilibrium Market Share

Two approaches are used for calculating the approach to equilibrium market share, one for new technologies or those being modeled as RET measures, and one for technologies simulated as ROB, or NEW measures.[30] A high-level overview of each approach is provided below.

[30] Each of these approaches can be better understood by visiting Navigant's technology diffusion simulator, available at: http://forio.com/simulate/navigantsimulations/technology-diffusion-simulation.

5.1.2.1 Retrofit Technology Adoption Approach

RET technologies employ an enhanced version of the classic Bass diffusion model[31,32] to simulate the S-shaped approach to equilibrium that is observed again and again for technology adoption. Figure 39 provides a stock/flow diagram illustrating the causal influences underlying the Bass model. In this model, market potential adopters "flow" to adopters by two primary mechanisms – adoption from external influences, such as marketing and advertising, and adoption from internal influences, or "word-of-mouth." The "fraction willing to adopt" was estimated using the payback acceptance curves illustrated in Figure 38.

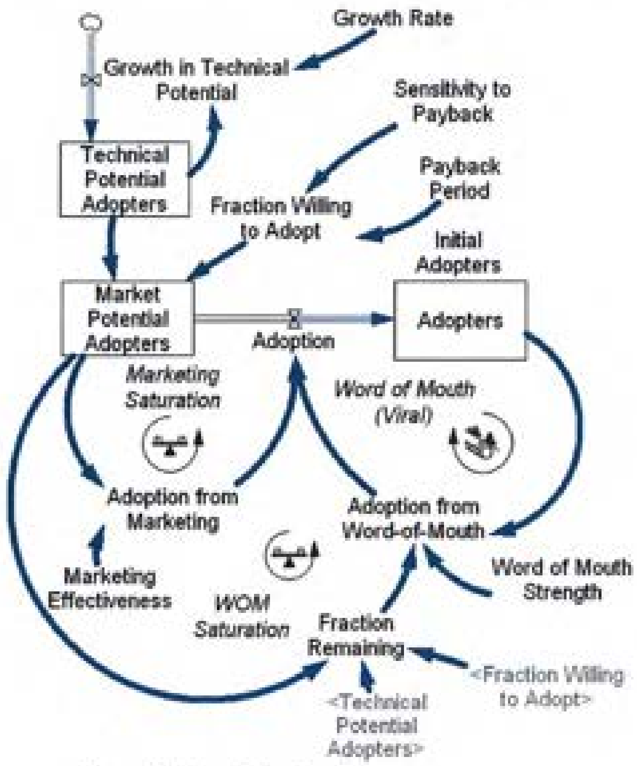
The marketing effectiveness and word-of-mouth parameters for this diffusion model were estimated drawing upon case studies where these parameters were estimated for dozens of technologies[33]. Recognition of the positive, or self-reinforcing, feedback generated by the "word-of-mouth" mechanism is evidenced by increasing discussion of the concepts such as social marketing as well as the term "viral," which has been popularized and strengthened most recently by social networking sites such as Twitter, Facebook and YouTube. However, the underlying positive feedback associated with this mechanism has been ever present and a part of the Bass diffusion model of product adoption since its inception in 1969.

[31] Bass, Frank (1969). "A new product growth model for consumer durables". Management Science 15 (5): p215–227.

[32] See Sterman, John D. *Business Dynamics: Systems Thinking and Modeling for a Complex World*. Irwin McGraw-Hill. 2000. p. 332.

[33] See Mahajan, V., Muller, E., and Wind, Y. (2000). New Product Diffusion Models. Springer. Chapter 12 for estimation of the Bass diffusion parameters for dozens of technologies. This model uses a value of 0.10 for the word-of-mouth strength in the base case scenario. The Marketing Effectiveness parameter for the base case scenario varied between 0.019 and 0.048, depending on the sector (values were determined as part of the calibration process). These values compare reasonably with the "most likely" value of 0.021 (75th percentile value is 0.055) per Mahajan 2000.

Figure 39. Stock/Flow Diagram of Diffusion Model for New Products and Retrofits



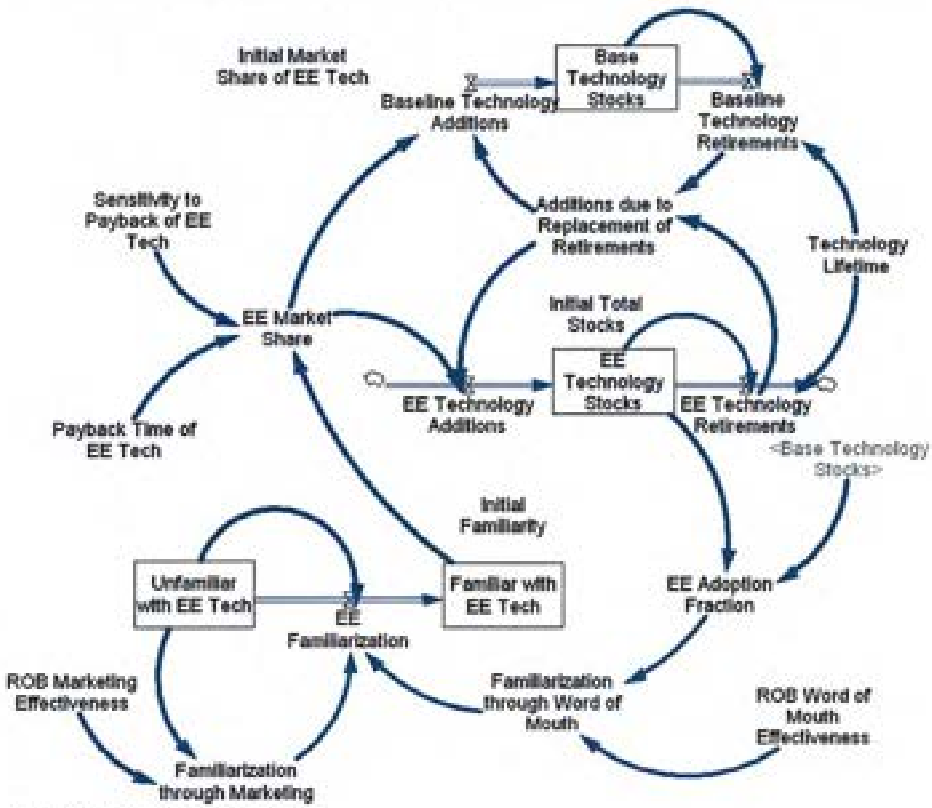
Source: Navigant Consulting, Inc.

The model illustrated above generates the commonly seen S-shaped growth of product adoption and is a simplified representation of that employed in DSMSim™.

5.1.2.2 Replace-on-Burnout Technology Adoption Approach

The dynamics of adoption for ROB technologies is somewhat more complicated than for NEW/RET technologies since it requires simulating the turnover of long-lived technology stocks. The DSMSim™ model tracks the stock of all technologies, both base and efficient, and explicitly calculates technology retirements and additions consistent with the lifetime of the technologies. Such an approach ensures that technology "churn" is considered in the estimation of market potential, since only a fraction of the total stock of technologies are replaced each year, which affects how quickly technologies can be replaced. A model that endogenously generates growth in the familiarity of a technology, analogous to the Bass approach described above, is overlaid on the stock tracking model to capture the dynamics associated with the diffusion of technology familiarity. A simplified version of the model employed in DSMSim™ is illustrated graphically in Figure 40.

Figure 40. Stock/Flow Diagram of Diffusion Model for ROB Measures



Source: Navigant Consulting, Inc.

5.1.3 Determining the Incentive Approach

One of the most important drivers for estimating achievable potential is the approach that is taken for modeling incentives. During various discussions with the Xcel Energy over the course of this project, Navigant presented a number of methodologies for addressing achievable potential. The initial proposal put forth by Navigant was to analyze various incentive approaches based on industry practice to estimate achievable potential and then ultimately select one approach that would serve as the reference case for the achievable potential. From there, Navigant would then conduct scenarios to see what the potential would be under the high- and low-funding scenarios.

Based on Navigant's experience, three possible incentive approaches for achievable potential were considered:

- Approach #1: Least Cost based on Levelized Cost – This approach is similar to a least cost dispatch of supply where the incentive amounts are set to accept all available efficiency measures up to a certain levelized cost criteria that is tied to avoided cost. The approach is described in detail in Welch, Richerson-Smith (2012). This approach first reduces the incentive levels (from a starting point of 100 percent) for those measures that are most expensive on a levelized cost basis. Measures that exceed this levelized cost will have incentives lower than 100 percent in proportion to their levelized cost. It is entirely possible that some measures would be so cost-effective from a levelized cost perspective that rebates that go to as high as 100 percent of incremental cost could be included.

- Approach #2: Percentage of Incremental Cost – This is where the rebate levels are set as a fixed percentage of the incremental cost. Under this approach, the level of savings would be achieved by paying some level (say at 50 or 70 percent) of incremental costs. It would be possible to set the rebates at different levels, depending on the sector or end-uses that are modeled. For example, there may be policy reasons why it would make sense to set rebate levels at higher amounts for end-uses that would target markets that are in the "highly inefficient" category.
- Approach #3: Targeted Payback– This approach varies incentive levels for each measure in order to reach a designated simple payback time in years. Rebate amounts are set to buy down the incremental cost of the DSM measure to a level that will result in the desired payback time, thus accounting for both the upfront cost of the measure as well as the annual expected savings to the customer.

Based on Navigant's past DSM potential modeling experiences, there are pros and cons to each approach. Navigant discussed each approach with Xcel Energy. It was determined that Approach #3 would best align with PUC objectives that all DSM programs be comprehensive in terms of customer segments and DSM measures.

The two other approaches have been analyzed by Navigant over the course of previous DSM potential studies. The results of Navigant's previous assessments for the two remaining approaches (percent of incremental cost versus Targeted payback) revealed that there tend to be no significant differences between the results of the two different approaches. Essentially the estimate of achievable potential based on a targeted payback approach or providing incentives as a percentage of incremental cost yielded a very similar distribution of potential across end uses and customer segments. The targeted payback approach yielded more comprehensive results in that less of the potential was derived from lighting and more from other measures. As such, Navigant recommended to Xcel Energy to adopt Approach #3 (Targeted Payback). Xcel Energy accepted Navigant's recommendation.

5.1.4 Model Calibration

Any model simulating *future* product adoption faces challenges with "calibration," as there is no future world against which one can compare simulated with actual results. Engineering models, on the other hand, can often be calibrated to a higher degree of accuracy since simulated performance can be compared directly with performance of actual hardware. Unfortunately, DSM potential models do not have this luxury, and therefore must rely on other techniques to provide both the developer and the recipient of model results with a level of comfort that simulated results are reasonable. For this Potential Study, Navigant took a number of steps to ensure that forecast model results were reasonable, including:

- Comparing 2018 forecast savings values, by sector, against Xcel Energy's projected program savings potential (calculated based on historical program performance), considering drivers of differences likely caused by changes in the measures.
- Comparing 2018 forecast incentive spending values, by sector, against Xcel Energy's projected incentive spending (calculated based on historical program costs), considering drivers of differences likely caused by changes in the measures.
- Calculating 2018 forecast portfolio-level savings as a percentage of electric or gas sales and comparing them with results observed in other jurisdictions.

Navigant adjusted model parameters including assumed incentive levels and technology diffusion coefficients to obtain close agreement across a wide variety of metrics compared for the Reference Scenario. This process ensures that forecast potential is grounded against real-world results considering the many factors that come into play in determining likely adoption of DSM measures, including both economic and non-economic factors.

5.2 Achievable Potential Savings Results – Reference Scenario

This section provides DSMSim™ results pertaining to the Reference Scenario for electric and gas achievable potential at different levels of aggregation. Results are shown by sector, customer segment, end-use, and by highest-impact measures. The Reference Scenario was deemed to represent a "business as usual" case, whereby Xcel Energy would continue implementing their DSM programs at comparable funding levels and for the most part continue to realize the energy savings that they have experienced from the past.

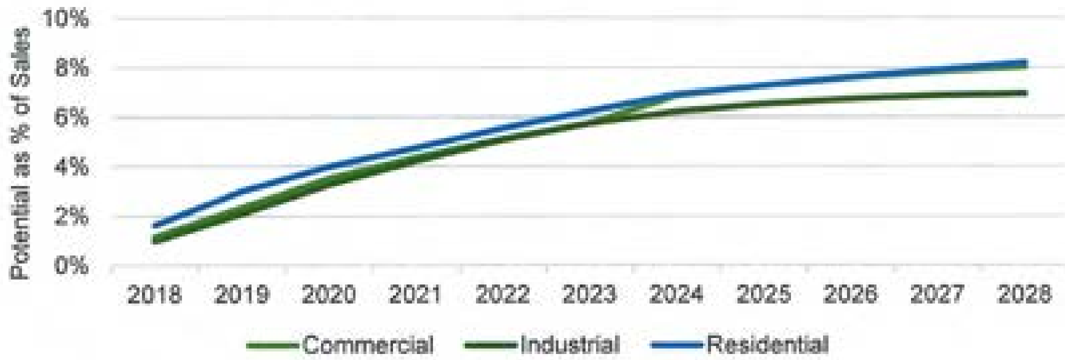
5.2.1 Overall Achievable Potential by Sector

As shown in Figure 41 and Table 16, achievable potential, which accounts for the rate of DSM acquisition, grows from 1.3 percent in 2018 to 7.8 percent of forecast net electric sales by 2028, or 0.7 percent per year on average over the Potential Study time horizon,[34] under the Reference Scenario. Figure 42 and Table 17 provide the comparable information for peak demand, with reductions growing from 1.2 percent in 2018 to 8.4 percent of forecast peak demand in 2028, or 0.8 percent per year on average over the same time horizon. Figure 43 and Table 18 provide the comparable information for gas, with savings growing from 0.4 percent in 2018 to 5 percent of forecast gas sales in 2028, or 0.5 percent per year on average over the same time horizon. Note that the data for these three tables include the Reference Scenario achievable potential as a percentage of forecast net electric and gas sales, respectively, in 2028.

Values shown below for achievable potential are termed "cumulative achievable" potential, in that they represent the accumulation of each year's annual incremental achievable (e.g., an annual achievable potential of 0.8 percent per year, for eleven years, would result in a cumulative achievable potential of 8 percent of forecast sales). Economic potential, as defined in this study, can be thought of as a bucket of potential from which programs can draw over time. Achievable potential represents the draining of that bucket, the rate of which is governed by a number of factors, including the lifetime of measures (for ROB technologies), market effectiveness, incentive levels, and customer willingness to adopt, among others. If the cumulative achievable potential ultimately reaches the economic potential, it would signify that all economic potential in the "bucket" had been drawn down, or harvested. We also see that achievable electric potential reaches 7.8 percent of forecast sales by 2028, meaning that more than half of economic potential (which is 17.8 percent of sales in 2028) has been harvested by the end of the Potential Study period. For gas, achievable potential reaches 6.2 percent of forecast sales by 2028, meaning that roughly 48 percent of economic potential (which is 10.4 percent of sales in 2028) has been harvested by the end of the Potential Study period.

[34] The time horizon for the Potential Study is 2018-2028 (11 years).

Figure 41. Total Electric Cumulative Achievable Potential as a Percentage of Forecast Electric Sales



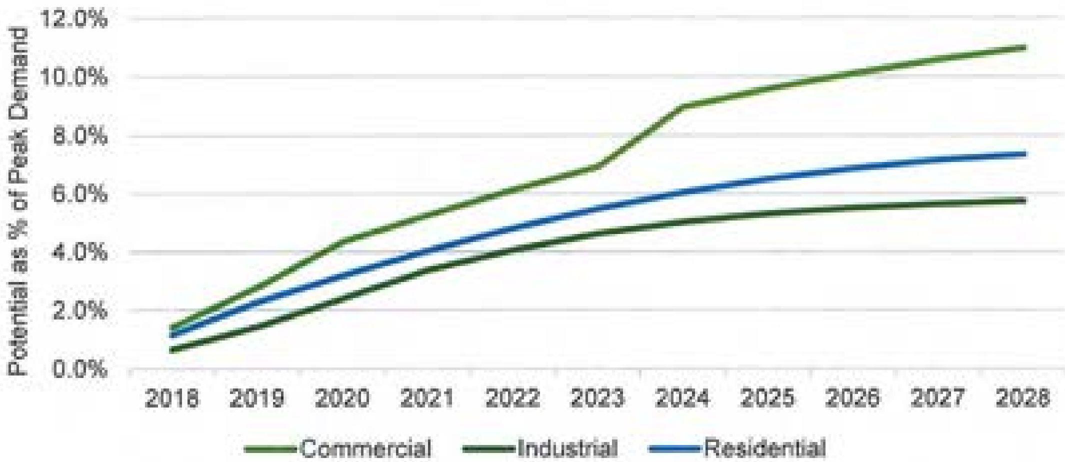
Source: Navigant analysis, 2016

Table 16. Total Electric Cumulative Achievable Potential as a Percentage of Electric Sales

Year	Commercial	Industrial	Residential	All Sectors
2018	1.1%	1.0%	1.6%	1.3%
2019	2.3%	2.1%	3.0%	2.5%
2020	3.5%	3.3%	4.0%	3.6%
2021	4.4%	4.2%	4.7%	4.4%
2022	5.1%	5.1%	5.5%	5.2%
2023	5.7%	5.7%	6.2%	5.9%
2024	6.8%	6.2%	6.9%	6.7%
2025	7.3%	6.5%	7.3%	7.1%
2026	7.6%	6.7%	7.6%	7.4%
2027	7.8%	6.9%	7.9%	7.6%
2028	8.0%	6.9%	8.2%	7.8%

Source: Navigant analysis, 2016

Figure 42. Total Electric Cumulative Achievable Potential as a Percentage of Forecast Electric Peak Demand



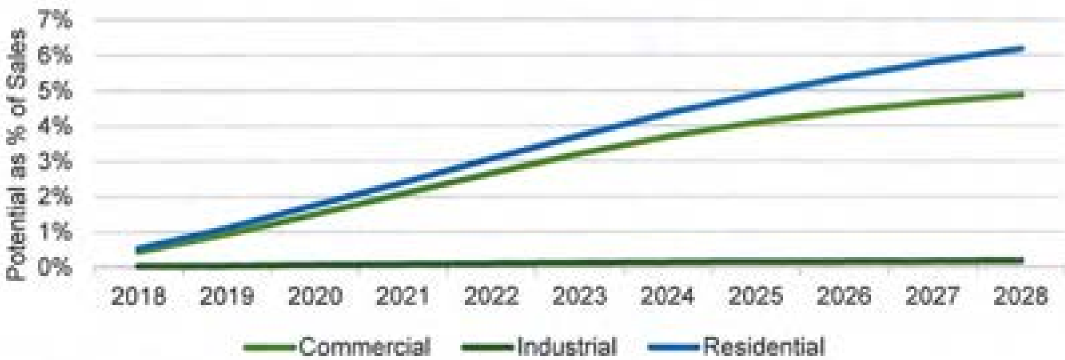
Source: Navigant analysis, 2016

Table 17. Total Electric Cumulative Achievable Potential as a Percentage of Electric Peak Demand

Year	Commercial	Industrial	Residential	All Sectors
2018	1.4%	0.6%	1.2%	1.2%
2019	2.8%	1.4%	2.3%	2.3%
2020	4.3%	2.4%	3.2%	3.5%
2021	5.3%	3.4%	4.0%	4.4%
2022	6.1%	4.1%	4.8%	5.2%
2023	6.9%	4.6%	5.5%	5.9%
2024	9.0%	5.0%	6.0%	7.0%
2025	9.6%	5.3%	6.5%	7.4%
2026	10.1%	5.5%	6.9%	7.8%
2027	10.6%	5.6%	7.1%	8.2%
2028	11.0%	5.7%	7.4%	8.4%

Source: Navigant analysis, 2016

Figure 43. Total Gas Cumulative Achievable Potential as a Percentage of Forecast Gas Sales



Source: Navigant analysis, 2016

Table 18. Total Gas Cumulative Potential as a Percentage of Gas Sales

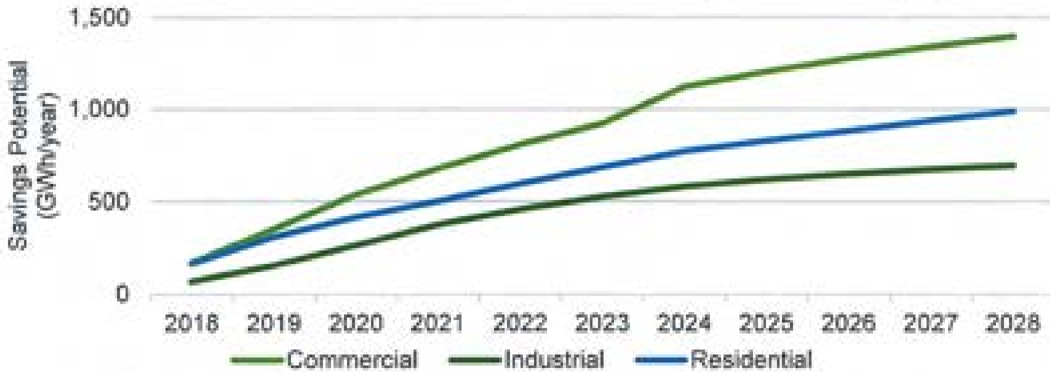
Year	Commercial	Industrial	Residential	All Sectors
2018	0.4%	0.0%	0.5%	0.4%
2019	0.9%	0.0%	1.1%	0.9%
2020	1.5%	0.1%	1.7%	1.4%
2021	2.1%	0.1%	2.4%	1.9%
2022	2.7%	0.1%	3.1%	2.5%
2023	3.2%	0.1%	3.7%	3.0%
2024	3.7%	0.1%	4.3%	3.5%
2025	4.1%	0.1%	4.9%	4.0%
2026	4.4%	0.2%	5.4%	4.3%
2027	4.7%	0.2%	5.8%	4.7%
2028	4.9%	0.2%	6.2%	5.0%

Source: Navigant analysis, 2016

Figure 44 and Table 19 shows the magnitude of electric achievable potential by sector. Figure 45 and Table 20 provides the comparable information for peak demand achievable potential. Figure 46 and Table 21 provides the comparable information for the gas achievable potential. The allocation of achievable potential among sectors is comparable with the allocation of forecasted sales among sectors. As previously noted, all savings reported in this Potential Study are net, rather than gross, meaning that the effect of possible free ridership is accounted for in the reported savings.

For electricity, the potential was found to be greatest in the residential sector (as a percent of sales). The potential in the commercial sector has been diminished by changes to lighting standards, which have reduced the potential for program driven savings. For natural gas, the gas achievable potential is more balanced between the residential and commercial sectors. The gas achievable potential for the industrial sector is very small, due largely to a minimal number of DSM measures that are applicable to that sector. This result is in line with Xcel's historical savings in the industrial sector.

Figure 44. Cumulative Electric Achievable Potential by Sector (GWh/year)



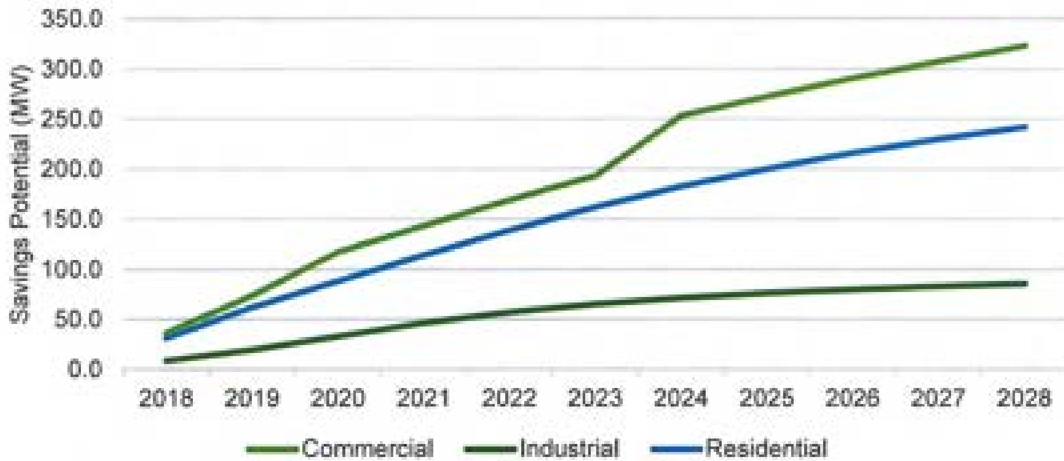
Source: Navigant analysis, 2016

Table 19. Cumulative Electric Achievable Potential by Sector (GWh/year)

Year	Commercial	Industrial	Residential	All Sectors
2018	168	68	163	399
2019	348	155	307	810
2020	538	263	414	1,215
2021	678	373	500	1,551
2022	808	456	595	1,859
2023	922	525	684	2,131
2024	1,121	579	771	2,470
2025	1,204	618	826	2,648
2026	1,275	648	881	2,805
2027	1,338	672	935	2,945
2028	1,394	694	985	3,073

Source: Navigant analysis, 2016

Figure 45. Cumulative Peak Demand Achievable Potential by Sector (MW)



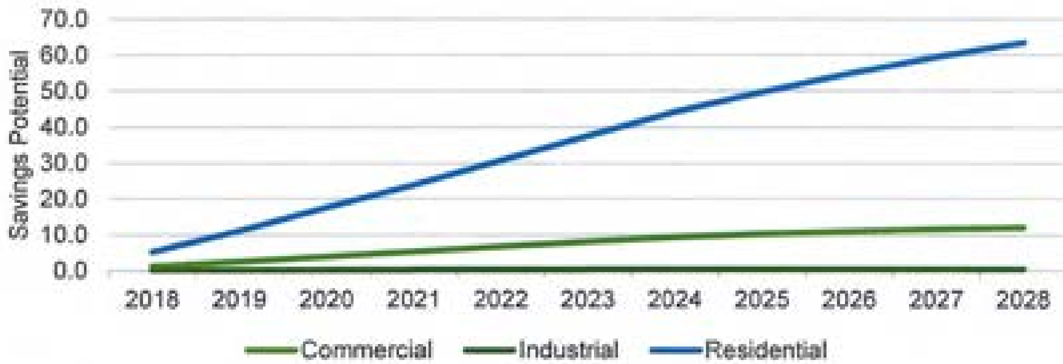
Source: Navigant analysis, 2016

Table 20. Cumulative Peak Demand Achievable Potential by Sector (MW)

Year	Commercial	Industrial	Residential	All Sectors
2018	36.3	8.4	30.9	75.5
2019	73.5	19.1	61.7	154.3
2020	117.2	32.6	88.2	238.0
2021	143.2	46.2	113.9	303.3
2022	168.8	56.4	138.9	364.1
2023	193.1	64.8	161.6	419.4
2024	252.7	71.2	182.1	506.0
2025	272.3	75.9	200.0	548.2
2026	290.4	79.5	215.8	585.7
2027	306.9	82.5	229.7	619.1
2028	322.6	85.1	241.7	649.4

Source: Navigant analysis, 2016

Figure 46. Cumulative Gas Achievable Potential by Sector (100,000 DTh/year)



Source: Navigant analysis, 2016

Table 21. Cumulative Gas Achievable Potential by Sector (100k DTh/year)

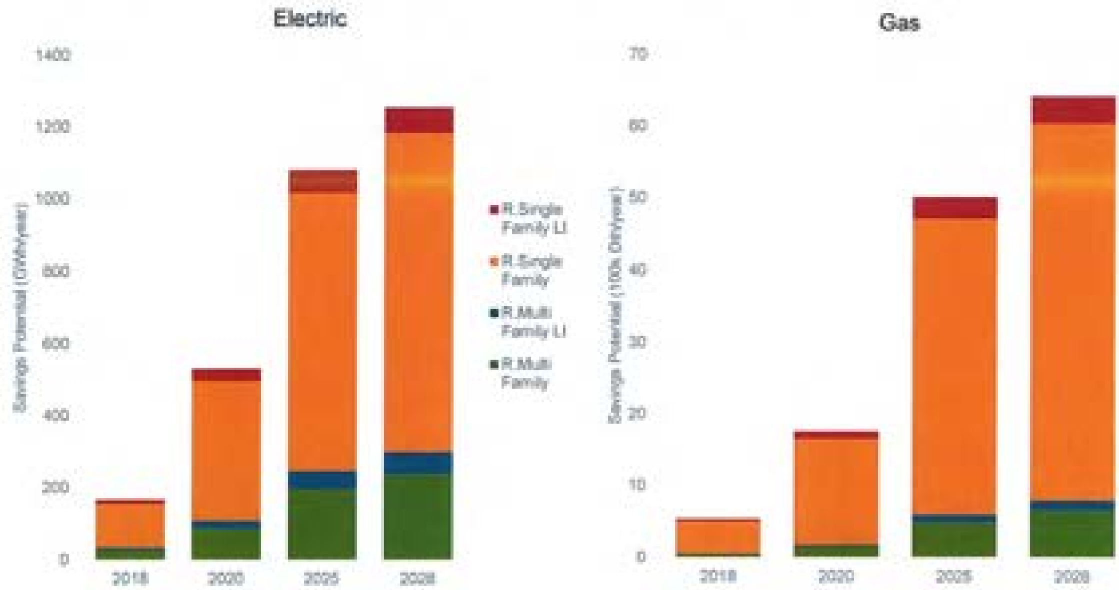
Year	Commercial	Industrial	Residential	All Sectors
2018	1.1	0.0	5.2	6.4
2019	2.4	0.1	11.1	13.6
2020	3.8	0.1	17.5	21.5
2021	5.3	0.2	23.9	29.4
2022	6.7	0.2	30.7	37.7
2023	8.1	0.3	37.5	45.9
2024	9.3	0.3	44.2	53.9
2025	10.3	0.4	49.7	60.3
2026	11.0	0.4	54.8	66.2
2027	11.6	0.4	59.4	71.4
2028	12.0	0.4	63.5	75.9

Source: Navigant analysis, 2016

5.2.2 Results by Customer Segment

The residential electric and gas achievable potentials shown in Figure 47 are broken out for selected years in the forecast for each of the four residential customer segments.

Figure 47. Cumulative Achievable Potential by Residential Customer Segment



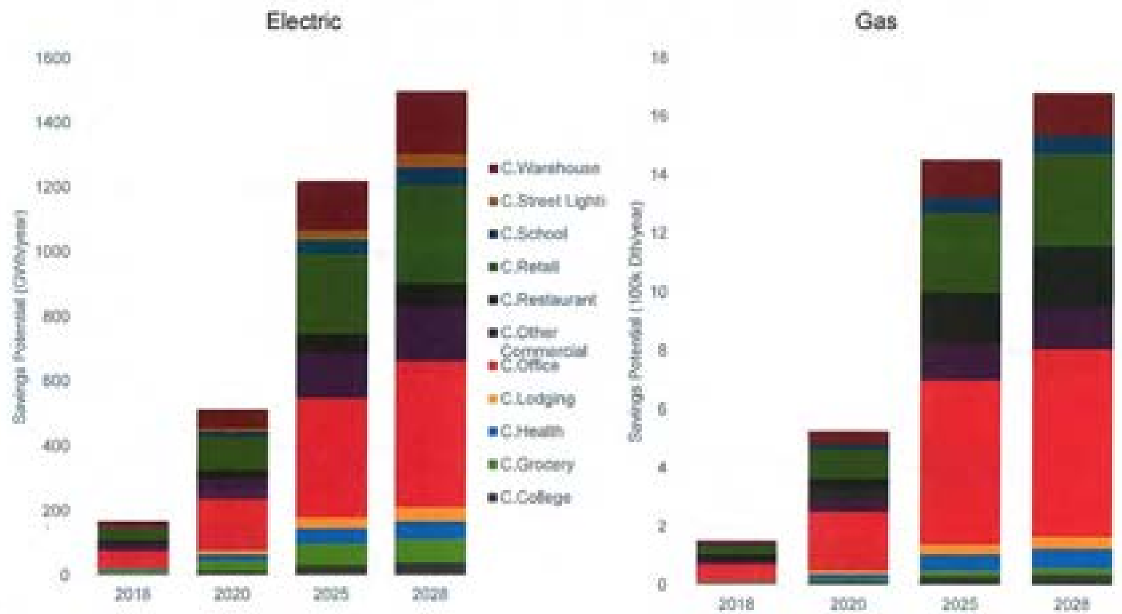
Source: Navigant analysis, 2016

The charts indicate a few noteworthy patterns:

- The single family segment has the most potential for energy efficiency savings in the Xcel Energy service territory. Growth in the single family potential over the 11-year time horizon is significant and consistent.
- The multi-family segment for the electric side contains a large amount of potential as well, growing significantly from 2018 to 2025 then tapering off somewhat.
- The low income segments (single-family and multi-family) do not have a significant amount of achievable potential. This smaller magnitude may be more of a function of the relatively small share of the base load that is captured by these market segments.

The commercial sector electric and gas achievable potentials shown in Figure 48 are broken out for selected years in the forecast for each of the 11 commercial customer segments.

Figure 48. Cumulative Achievable Potential by Commercial Customer Segment



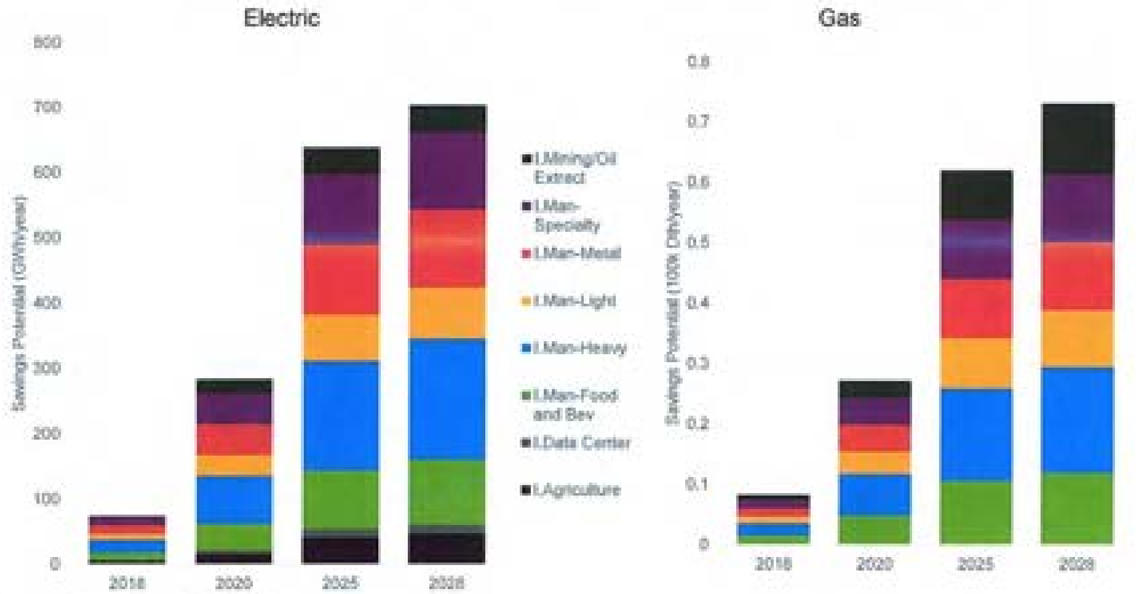
Source: Navigant analysis, 2016

The charts indicate a few noteworthy patterns:

- Offices, retail stores, other commercial and warehouses have the largest amount of achievable electric potential with healthy levels of growth for all of these segments during the 11-year forecast period. These dominant segments for the commercial electric achievable potential might be a function of their larger share of baseline energy usage.
- Offices, retail stores, restaurants and other commercial appear to have the largest amount of achievable gas potential. This finding is driven by both the applicable measure mix for these building types and the share of gas usage that is reflected for this building types in the baseline.

The industrial/ag sector electric and gas achievable potentials shown in Figure 49 are broken out for selected years in the forecast for each of the seven industrial customer segments.

Figure 49. Cumulative Achievable Potential by Industrial/Ag Customer Segment



Source: Navigant analysis, 2016

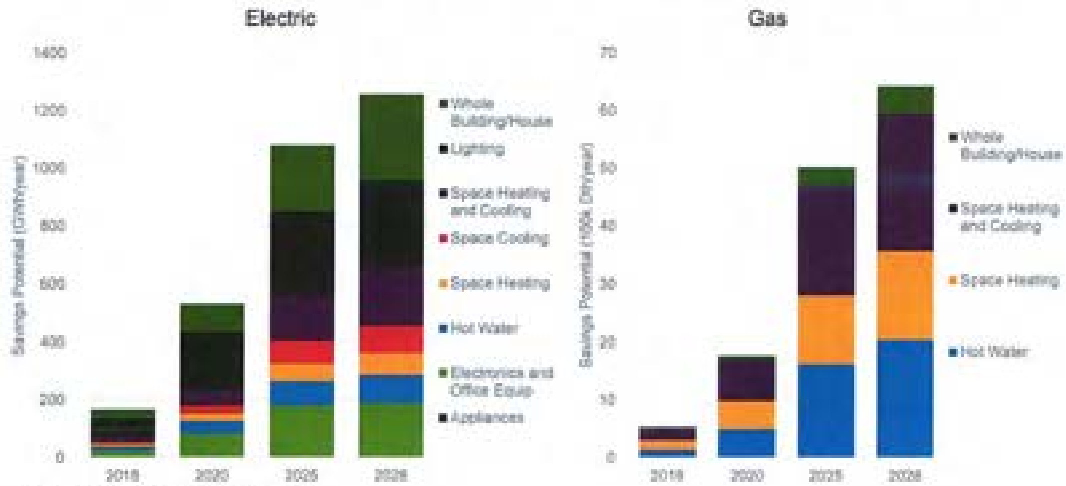
The charts indicate a few noteworthy patterns:

- The following industrial segments appear to have the largest electric achievable potential over the forecast period: heavy manufacturing, specialty manufacturing, metals manufacturing, and food/beverage. This result reflects large process loads driven by motor requirements thus large potential exists for motor-related efficiency improvements including premium efficiency motors, variable speed drives and a number of process-specific improvements.
- The following industrial segments appear to have the largest gas achievable potential over the forecast period: heavy manufacturing, specialty manufacturing, metals manufacturing, food/beverage, and ultimately light manufacturing (in the latter years). This result also reflects large process loads driven primarily by process heat and cooling requirements thus large potential exists for process-related energy efficiency improvements including efficient boilers, absorption chillers, and a number of process-specific improvements.

5.2.3 Results by End-Use

The residential electric and gas achievable potentials shown in Figure 50 are broken out for selected years in the forecast for each of the end-uses.[35]

Figure 50. Cumulative Achievable Potential by Residential Sector End-Use



Source: Navigant analysis, 2016

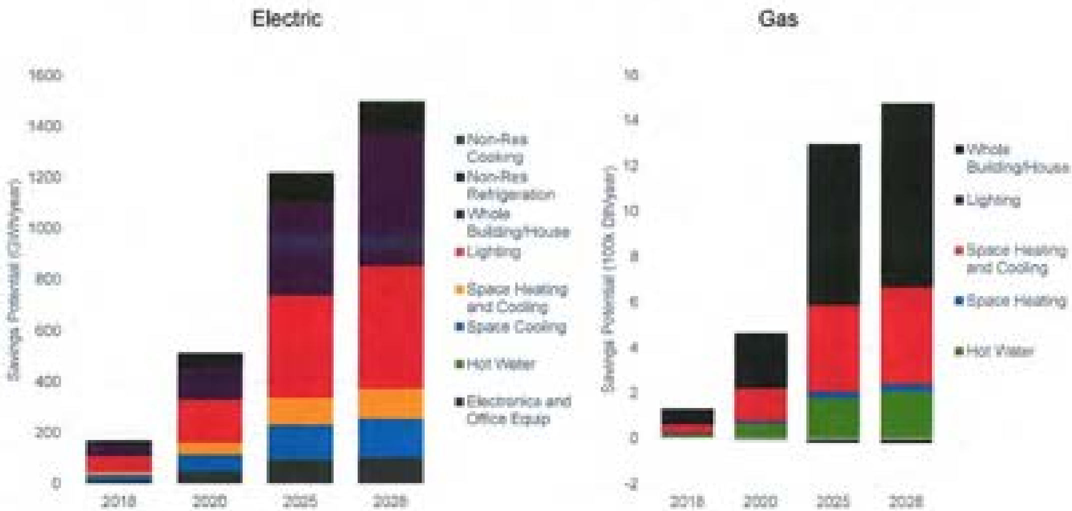
The charts indicate a few noteworthy patterns:

- Whole-house measures and lighting are the largest contributors to electric achievable potential over the forecast horizon.
- Savings for lighting measures appear to take a significant jump from 2018 to 2020, due to significant penetration of CFLs replacing the baseline incandescent bulbs before they become the baseline after 2020 due to planned changes to EISA standards at that time. After the standard change, incremental potential from lighting is greatly reduced.
- Combined space heating and cooling potential (for example, insulation measures) for both electric and gas grow significantly over the latter part of the forecast. This comes about due to significant amounts of stock turnover during the latter years of the forecast horizon, as well as greater cost-effectiveness as avoided costs (particularly gas) increase. Higher avoided costs drive increased market shares particularly in gas heated, electric cooled homes.
- Electronic and office equipment potential also increases significantly between 2020 and 2025, reflecting greater levels of stock turnover.

[35] End-use breakdowns by customer segment specific to Xcel Energy's Colorado territory were not available. As such, U.S. Department of energy Commercial Building Energy Consumption Survey (CBECS) data for the Rocky Mountain region was used.

The commercial sector electric and gas achievable potentials shown in Figure 51 are broken out for selected years in the forecast for each of the end-uses.

Figure 51. Cumulative Achievable Potential by Commercial Sector End-Use



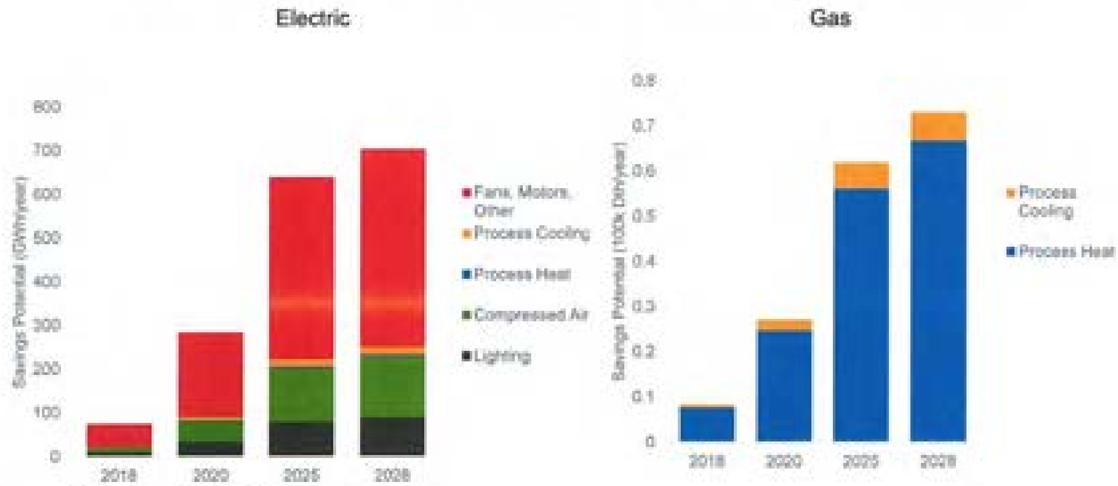
Source: Navigant analysis, 2016

The charts indicate a few noteworthy patterns:

- The whole building end-use contains the largest amount of achievable potential for both electric and gas. This reflects the significant growth in new construction activities for the commercial sector during the forecast period within Xcel Energy's service territory. It should be noted that Navigant did not include the impact of any future standards that could affect potential but are not currently in place or known to come into effect during the forecast horizon.
- Lighting also shows significant potential in the commercial sector. In contrast with the residential sector, LEDs gain greater market share, particularly after 2020 when EISA standards kick in and new efficiency measures gain momentum in the commercial marketplace.
- Space heating and cooling are the dominant end-uses for gas achievable potential in the commercial sector.

The industrial/ag sector electric and gas achievable potentials shown in Figure 52 are broken out for selected years in the forecast for each of the end-uses.

Figure 52. Cumulative Achievable Potential by Industrial/Ag Sector End-Use



Source: Navigant analysis, 2016

The charts indicate a few noteworthy patterns:

- The industrial process-related end-uses including fans, motors, and compressed air on the electric side and process heat on the gas side offer the most significant achievable potential savings. These also tend to be low-cost measures, which drives the overall low acquisition cost seen in the industrial sector.
- A large amount of growth in electric potential is experienced between 2020 and 2025 for the industrial sector which have more to do with the assumptions embedded in Xcel Energy's forecasted load growth than technology diffusion in the marketplace.

5.2.4 Results by Measure

Table 22 shows the top ranking electric DSM measures along with their cumulative achievable potential in 2025. The top achievable electric measures include commercial new construction, CFLs in the residential sector, LED fixtures in the commercial sector, and variable frequency drives for pumps and fans in the commercial and industrial sectors. As the figures for 2025 illustrate the savings from each of the top measures accumulate over time, and in some instances the importance of measures changes over the period. For example, the relative ranking of CFLs decreases over the period, reflecting the changing baseline and increasing penetration of other bulbs. Several measures, such as CFLs, heat pumps, and advanced power strips have large barriers to entry that are not captured in the economics of the measure. For example, consumers may dislike CFL warm up times, and be willing to purchase a slightly more expensive bulb. For these measures, exogenous adders on the payback time were introduced to lower the long-run market share of the measure and simulate these barriers to program participation.

Table 23 shows the comparable information for gas DSM measures. The greatest areas of residential gas achievable potential were found to include efficient showerheads, furnace replacements, reducing air infiltration, programmable thermostats, and Energy Star homes. For commercial, the bulk of the savings come from furnace replacements. Unlike the electric potential the relative ranking of measures does not change significantly over time.

Table 22. Top 20 DSM Measures for Electric Achievable Potential by 2025 (GWh/year)

Rank	Measure	Achievable Potential
1	Com | New Construction	347
2	Res | Energy Star CFL Bulbs	207
3	Com | LED Fixture	163
4	VSD on Pumps	122
5	VSD on Fans	111
6	Res | Energy Star Home	95
7	Com | HVAC Control Upgrades	91
8	Res | Home Energy Reports	86
9	Com | LED Exit Sign	69
10	Central Furnace Efficient Fan Motor (ECM)	62
11	Ind | Air Compressor VFD	53
12	Ind | Pump Sizing	51
13	Res | Energy Efficient Building	50
14	Res | Heat Pump Water Heater	47
15	Com | Wall Insulation (Small Business)	46
16	Res | Indoor Fluorescents T8	46
17	High Bay Fixtures	43
18	Res | Low Flow Showerheads	42
19	Com | CFL	41
20	Ind | Air Compressor Optimization	40

Source: Navigant 2016.

Table 23. Top 20 DSM Measures for Gas Achievable Potential by 2025 (100k DTh/year)

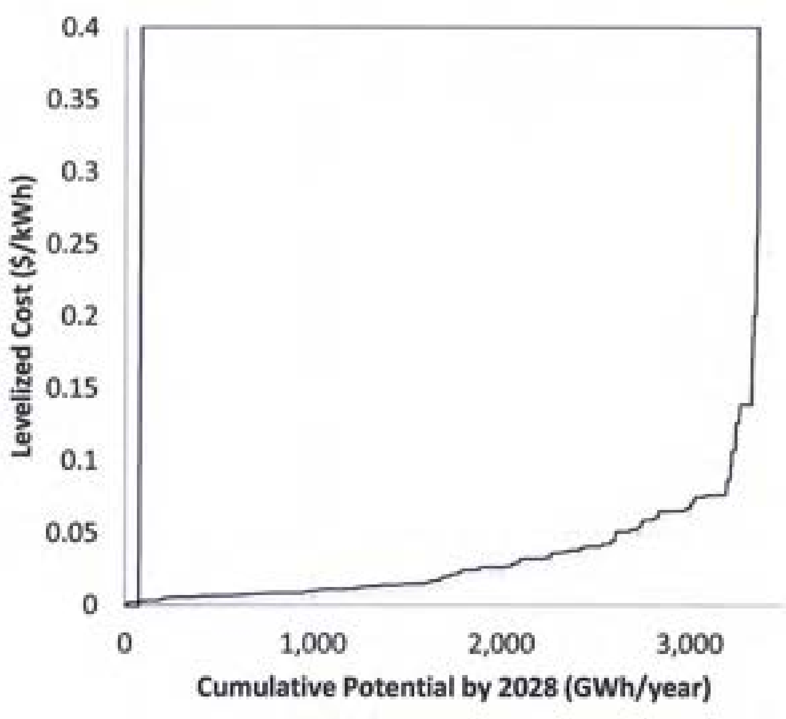
Rank	Measure	Achievable Potential
1	Res | Low Flow Showerheads	13.1
2	Gas Furnace Replacement	12.4
3	Res | Duct Insulation	5.5
4	Res | Programmable Thermostat	4.3
5	Res | Energy Star Home	3.3
6	Com | Wall Insulation (Small Business)	3.2
7	Com | Energy Management System	2.6
8	Res | Home Energy Reports	2.5
9	Res | Water Heater Jacket	2.3
10	Res | Bathroom Faucet Aerator	2.3
11	High Efficiency Boiler Replacement	1.3
12	Com | Boiler – SHW	1.1
13	Com | Gas Steam Cooker	0.8
14	Res | Water Heater Temp Setback	0.7
15	Res | Energy Efficient Building	0.7
16	Res | Kitchen Faucet Aerator	0.7
17	Com | Ceiling/Roof Insulation (Small Business)	0.6
18	Com | Gas Ovens	0.5
19	Res | Smart Thermostat	0.5
20	Com | Instantaneous Water Heater	0.4

5.2.5 Achievable Potential Supply Curves

The achievable potential supply curves are provided in this section. Levelized costs include the discounted lifetime savings for a given measure, and thus account for variable measure lifetimes and savings persistence. An energy efficiency resource potential supply curve illustrates the cumulative amount of achievable potential at various price points along a range of levelized cost. All measures are plotted with their corresponding cumulative potential and the corresponding levelized cost to achieve that potential. The lowest cost measures appear on the left-hand side of the chart. Each next highest cost measure is stacked on top of the previous measures in ranked order.

Figure 53 provides the supply curve results for the electric results of the reference scenario. As can be seen from the chart, roughly four-fifths of the electric achievable potential savings can be achieved for a lifetime levelized cost of under $0.05/kWh. The remaining fifth of the potential can be achieved, but at significantly higher costs.

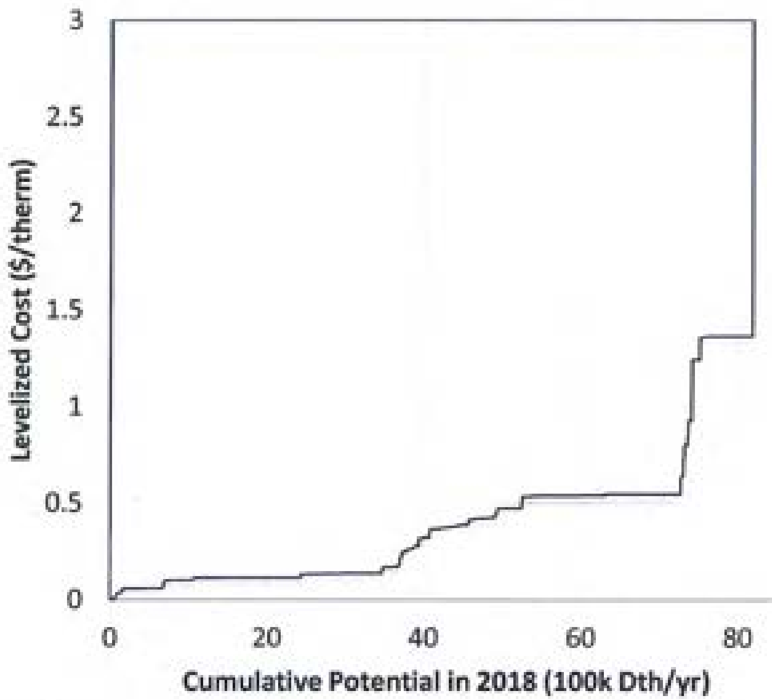
Figure 53. Electric Achievable Potential Supply Curve, All Sectors



Source: Navigant analysis, 2016

Figure 54 provides the comparable information for gas. As can be seen from the chart, roughly two-thirds of the gas achievable potential savings can be achieved for a lifetime levelized cost of under $0.50/therm. The remaining third of the potential can be achieved, but at significantly higher costs.

Figure 54. Gas Achievable Potential Supply Curve, All Sectors



Source: Navigant analysis, 2016

5.2.6 Budget Estimates

Navigant developed estimates of DSM program funding needed to support the various levels of achievable potential to be obtained during the study period. Table 24 presents the estimated funding levels for incentives, program administration and total for electric and gas under the Reference scenario. These estimates were calculated in the DSMSim™ model and reflect calibrated incentive levels based on the targeted payback approach described in this chapter. The incentive budgets reflect the amount of spending that would result from the level of adoption for each measures that make up the achievable potential estimates. Incentive values grow over time due changes in the mix of DSM measures and cost inflation. The program and portfolio administration budgets are based on historical expenditures for administration reported by Xcel Energy. In order to keep projections conservative, program administration cost are assumed to remain constant over the planning horizon.

As can be seen from the table, the total simulated funding that corresponds with the Reference Scenario achievable potential is $98.34 in 2018, and reducing to just under $90 million by 2028. Nearly 85 percent of the funding is attributable to electric DSM program efforts.

Table 24. Estimated DSM Program Funding, Reference Scenario (Million $)

Year	Electric			Gas			Total Funding
	Incentive	Administration	Total	Incentive	Administration	Total	
2018	35.05	46.81	81.86	10.86	5.62	16.48	98.34
2019	38.90	46.81	85.71	11.90	5.62	17.52	103.23
2020	44.23	46.81	91.04	13.04	5.62	18.66	109.70
2021	44.52	46.81	91.33	12.77	5.62	18.40	109.72
2022	48.01	46.81	94.82	13.58	5.62	19.21	114.02
2023	48.41	46.81	95.21	13.82	5.62	19.44	114.65
2024	50.11	46.81	96.92	13.44	5.62	19.06	115.97
2025	40.05	46.81	86.85	11.79	5.62	17.41	104.26
2026	36.03	46.81	82.84	11.16	5.62	16.78	99.62
2027	31.85	46.81	78.66	10.26	5.62	15.89	94.55
2028	27.76	46.81	74.56	9.35	5.62	14.97	89.54

Source: Navigant analysis, 2016

5.3 Achievable Potential Savings Results – Alternative Scenarios

5.3.1 Approach to Alternative Scenario Analysis

Although this study was not intended to include program design aspects, Navigant acknowledges the large variation in savings that can result from factors such as variable incentive rates and market availability, independent of other adoption drivers such as access to information and marketing efforts. In an effort to provide reasonable boundaries for the results of this Potential Study, Navigant developed the following alternative estimates of achievable potential: Max Utility Benefits and Low Utility Benefits, and Alternative Lighting. The Max Utility Benefits and Low Utility Benefits scenarios were developed to correlate incentive spending with the Utility Cost Test net benefits. Through parametric sensitivity testing, Navigant determined that at certain levels, increased participation leads to higher net benefits. Similarly, lower participation can lead to lower net benefits.

Thus, the Max Utility Benefits scenario reflects increases in customer incentives that will lead to greater numbers of participants for the DSM programs, along with increased levels of customer awareness. The Low Utility Benefits scenario reflects decreases in customer incentives that will lead to fewer numbers of participants of the DSM programs and resulting decreases in customer awareness.[36] The Lighting Scenario reflects a switch between LED lighting measures and CFL measures, where the former penetrates the Colorado marketplace much faster than was assumed in the Reference Scenario. For all alternative scenarios, administrative spending was held constant.

As noted above, the Low and Max scenarios were created through analysis on the relationship between incentive levels (through the targeted payback period). As such, for each sector, the targeted simple payback period was varied between 0 and 20 years. The Max Utility Benefits scenario was selected as the incentive level that maximized the net benefits according to the Utility Cost Test (UCT). Thus, the Max Utility Benefits scenario reflects the optimal incentive level from a UCT perspective. The Low Utility Benefits scenario was selected to reflect a similar change in the incentive level, but in the opposite direction, and where there was an inflection point in the UCT net benefits. The selected targeted payback periods used in the three scenarios are shown in Table 25 below. It is noteworthy how close the Reference case targeted payback periods, which were calibrated to Xcel's DSM program spending and savings levels, are to the Max Utility Benefits levels, particularly for the Commercial and Industrial sectors.

Table 25. Targeted Paybacks by Scenario (years)

Scenario	Commercial	Industrial	Residential
Reference	5.0	3.0	2.3
Max Utility Benefits	4.0	2.5	0.5
Low Utility Benefits	6.5	4.5	4.5

Source: Navigant 2016.

The Alternative Lighting Scenario reflects an accelerated uptake of LED lighting measures relative the Reference Scenario. Note that for the Reference Scenario, CFL measures are assumed to take a larger share of the market over the first two years of the forecast (2018 and 2019), despite accounting for non-economic barriers to adoption, due to the fact that those measures are the most cost-effective lighting options in the residential sector. LED costs are assumed to be high during the early years of the forecast, and over time, those costs decline. As such, the bulk of the stock turnover goes to the most cost-effective high efficiency option, which is CFLs. Starting in 2020, however, CFLs will become the baseline per EISA federal standards. This means that LEDs will take the place of CFLs starting in 2020 and become the most cost-effective lighting measure competing with the new baseline.

In the Alternative Lighting Scenario, additional barriers to CFL adoption are added to simulate market availability restrictions. This change enables LEDs to take a greater share of the market relative to CFLs starting in the first year. This scenario shifts acquisition cost for savings higher on a $/kWh basis due to the relative cost differential between CFLs and LEDs. Thus, for a similar spending level, less savings is achievable in the Alternative Lighting Scenario relative to the Reference Scenario.

[36] To capture the increased customer awareness in the DSMSim™ model, adjustments are made to the *Marketing Factors*. These adjustments are based on product diffusion literature. See Mahajan, V., Muller, E., and Wind, Y. (2000). New Product Diffusion Models. Springer. Chapter 12.

5.3.2 Results of Max Utility Benefits Scenario

Table 26 provides a summary of the results of the Max Utility Benefits scenario. The table provides a comparison to the Reference Scenario. Table 27 provides the comparable information for gas. As mentioned above, administrative spending was held constant at Reference Case levels. The tables reveal the following insights:

- For electric, savings increase by approximately 12 percent in 2018 and are 10 percent larger than the reference case by 2028. This translates into a 0.1 percent increase in the percentage savings in 2018 and 0.8 percent increase in the percent reduction by 2028. Regarding the budget, the Max Utility Benefits scenario leads to a 43 percent increase in the annual budget in 2018 and a 23 percent increase by 2028. This scenario illustrates the point that in order to get an additional 307 GWh savings by 2028, Xcel Energy would have to spend an additional $17-30 million each year for incentives paid to participants over the 11-year forecast period to achieve those savings—assuming that program admin costs could be capped at existing levels.
- For gas, savings increase by approximately 50 percent in 2018 and are 22 percent larger than the reference case by 2028. This translates into a 0.2 percent increase in the percentage savings in 2018 and 1 percent increase in the percent reduction by 2028. Regarding the budget, the Max Utility Benefits scenario leads to a 70 percent increase in the annual budget in 2018 and a 50 percent increase by 2028. This scenario illustrates the point that in order to get an additional 16.6 Million Dth savings by 2028, Xcel Energy would have to spend an additional $7-10 million each year for incentives paid to participants over the 11-year forecast period to achieve those savings.

Table 26. Electric Achievable Potential for Max Utility Benefits Scenario Relative to Reference

Year	Cumulative Savings (GWh)	Percent of Sales	Annual Budget (Million$)
	Max Utility Benefits Scenario		
2018	447	1.4%	$116.9
2019	901	2.8%	$119.9
2020	1,354	4.0%	$127.9
2025	2,923	7.8%	$103.4
2028	3,380	8.6%	$91.8
	Reference Scenario		
2018	399	1.3%	$81.9
2019	810	2.5%	$85.7
2020	1,215	3.6%	$91.0
2025	2,648	7.1%	$86.9
2028	3,073	7.8%	$74.6

Source: Navigant analysis, 2016

Table 27. Gas Achievable Potential for Max Utility Benefits Scenario Relative to Reference

Year	Cumulative Savings (100s Dth)	Percent of Sales	Annual Budget (Million $)
Max Utility Benefits Scenario			
2018	9.6	0.6%	$27.8
2019	20.6	1.3%	$30.1
2020	32.8	2.1%	$33.3
2025	79.3	5.2%	$25.5
2028	92.5	6.0%	$22.5
Reference Scenario			
2018	6.4	0.4%	$16.5
2019	13.6	0.9%	$17.5
2020	21.5	1.4%	$18.7
2025	60.3	4.0%	$17.4
2028	75.9	5.0%	$15.0

Source: Navigant analysis, 2016

5.3.3 Results of Low Utility Benefits Scenario

Table 28 provides a summary of the results of the Low Utility Benefits scenario. The table provides a comparison to the Reference Scenario. Table 29 provides the comparable information for gas. As mentioned above, administrative spending was held constant at Reference Case levels. The tables reveal the following insights:

- For electric, savings decrease by approximately 6 percent for each year in the 11-year forecast period. This translates into a 0.1 percent decrease in the percentage savings in 2018 and 0.5 percent decrease in the percent reduction by 2028. Regarding the budget, the Low Utility Benefits scenario leads to a nearly 30 percent reduction in the annual budget in 2018 and a 10 percent decrease by 2028. This scenario illustrates the point that if Xcel Energy were to spend an average of $12 million a year less for incentives to participants, this would lead to an erosion of 217 GWh of savings by 2028.
- For gas, savings decrease by approximately 25 percent in 2018 and are 20 percent smaller than the reference case by 2028. This translates into a 0.1 percent decrease in the percentage savings in 2018 and 0.9 percent decrease in the percent reduction by 2028. Regarding the budget, the Low Utility Benefits scenario leads to a nearly 40 percent decrease in the annual budget in 2018 and a 30 percent decrease by 2028. This scenario illustrates the point that Xcel Energy would see a reduction of 14 million Dth by spending roughly $4-5 million less on incentives to participants each year over the 11-year forecast period.

Table 28. Electric Achievable Potential for Low Utility Benefits Scenario Relative to Reference

Year	Cumulative Savings (GWh)	Percent of Sales	Annual Budget (Million $)
	Low Utility Benefits Scenario		
2018	374	1.2%	$63.7
2019	758	2.3%	$65.5
2020	1,132	3.4%	$67.7
2025	2,436	6.5%	$69.6
2028	2,865	7.3%	$67.3
	Reference Scenario		
2018	399	1.3%	$81.9
2019	810	2.5%	$85.7
2020	1,215	3.6%	$91.0
2025	2,648	7.1%	$86.9
2028	3,073	7.8%	$74.6

Source: Navigant analysis, 2016

Table 29. Gas Achievable Potential for Low Utility Benefits Scenario Relative to Reference

Year	Cumulative Savings (100k Dth)	Percent of Sales	Annual Budget (Million $)
	Low Utility Benefits Scenario		
2018	4.9	0.3%	$10.1
2019	10.4	0.7%	$10.5
2020	16.5	1.1%	$10.9
2025	47.6	3.1%	$11.1
2028	62.0	4.1%	$10.6
	Reference Scenario		
2018	6.4	0.4%	$16.5
2019	13.6	0.9%	$17.5
2020	21.5	1.4%	$18.7
2025	60.3	4.0%	$17.4
2028	75.9	5.0%	$15.0

Source: Navigant analysis, 2016

5.3.4 Results of Alternative Lighting Scenario

Table 30 provides a summary of the results of the alternative lighting scenario. The table provides a comparison to the Reference Scenario. No changes were observed for the gas impacts as a result of this scenario so no table is provided gas. As mentioned above, administrative spending was held constant at Reference Case levels. The results reveal the following insights:

- For this scenario, savings decreased by 18 percent in the first year. This was due to the fact that CFLs were being replaced by LEDs, which have a lower unit savings. However, by 2028, the overall savings reduction amounts to a mere 6 percent relative to the Reference Scenario.
- Regarding the budget, this scenario leads to a nearly 7 percent increase in the annual budget in 2018. This is due to the fact that in the early years, LEDs have a significantly higher cost than CFLs. However, by 2028, the cost difference is relatively insignificant (less than 1 percent higher than the Reference Scenario) due mainly to anticipated price reductions for LEDs over time.
- This scenario illustrates the point that if Xcel Energy were to accelerate the deployment of LEDs over CFLs, there would be a drop in savings for higher cost. There may be offsetting factors that could mitigate this risk (e.g., if LED costs come down faster than what we had projected) but based on our analysis, it would appear that CFLs are still the most cost-effective high efficiency lighting measure in the residential market, at least until 2020 when CFLs become the baseline due to the EISA standards.

Table 30. Electric Achievable Potential for Alternative Lighting Scenario Relative to Reference

Year	Cumulative Savings (GWh)	Percent of Sales	Annual Budget (Million $)
	Alternative Lighting Scenario		
2018	328	1.1%	$87.2
2019	677	2.0%	$89.8
2020	1,072	2.9%	$93.5
2025	2,474	6.1%	$86.3
2028	2,883	7.1%	$74.0
	Reference Scenario		
2018	399	1.3%	$81.9
2019	810	2.5%	$85.7
2020	1,215	3.6%	$91.0
2025	2,648	7.1%	$86.9
2028	3,073	7.8%	$74.6

Source: Navigant analysis, 2016

5.4 Upstream Market Actor Survey Results

In order to better understand the market context and trends underlying the residential and C&I surveys conducted with customers in Xcel Energy's territory, Navigant asked 26 market actors to provide feedback on the state of the market for energy efficient measures and technologies, as discussed in Section 2.2.6. The qualitative findings from these surveys provide market context and help drive the narrative around the results of this Potential Study. This section presents the key findings from the market actor surveys, with the more detailed results provided in Appendix D.

Navigant asked market actors to comment on which measures they thought end users had the most and least familiarity.

Table 36 shows that lighting measures and HVAC equipment are generally well known in both the residential and commercial sectors, with many of the market actor responses referencing lighting for this question specifically mentioned LEDs. Residential customers are also familiar with insulation measures and commercial customers are familiar with motors and drives. Air sealing and water heater equipment are generally less well known in the residential sector.

Table 31. End User Awareness of Efficient Technologies/Measures

	Residential		Commercial		Industrial	
Measures	Most Well Known	Least Well Known	Most Well Known	Least Well Known	Most Well Known	Least Well Known
Lighting	6	2	11	1	1	
HVAC	4	1	5			
Motors and Drives			4	2	1	
Solar PV[37]			3			
VFD			3	3		
Boilers	1		2			
Chillers			2			
Insulation	5	1				
Evaporative Coolers	3	1				
Furnaces	3					
Appliances	2					
Water Heaters	2	3				
Air Sealing	1	4				
Smart Metering				2		

Source: Navigant Market Actor Surveys 2016; n=26; Multiple responses accepted. Table provides count of mentions by market actors. Measures with no more than one response have been omitted from this table, but are presented in Appendix D.

Navigant additionally asked market actors to comment on which measures they anticipate would decrease the most in price over the next five and ten years. Table 37 shows that there is relative consensus that LED bulbs will decline in price in the coming five years. This expectation aligns with the treatment of LED prices in this Potential Study—as shown in Appendix E.2, the analysis includes cost multipliers to account for the anticipated decrease in LED price over time.

In the residential sector, market actors also predict the price will decline for HVAC technologies. For the commercial sector, several market actors indicated an expected price drop in Solar PV and ECM motor technology.

[37] Questions to market actors were open-ended, so some market actors responded more broadly about other distributed energy resources, beyond energy efficiency. These responses are included here for completeness.

Table 32. Measures/Technologies Predicted to Decline Most in Price

	Residential		Commercial		Industrial	
Measures	Next 5 Years	Next 10 Years	Next 5 Years	Next 10 Years	Next 5 Years	Next 10 Years
LEDs	6	3	8	3		
HVAC	4	4	2	1		
Water Heaters	2	2				
Solar PV	2		3	2		
Appliances	1	2				
Refrigerant	1	1				
ECM Motors			3	1		
VFD			2	1		
EMS			2			
Lighting Controls			2	2		

Source: Navigant Market Actor Surveys 2016; n=26; Multiple responses accepted. Table provides count of mentions by market actors. Measures with no more than one response have been omitted from this table, but are presented in Appendix D.

To follow up on the decline in price, Navigant also asked market actors which measures or technologies they expect to increase the most in efficiency over the next five and ten years, respectively. Similar to expected decreases in price, market actors in both the residential and commercial sectors predict that LED bulbs will see a large increase in efficiency in the coming years. HVAC equipment and building controls are also predicted to experience notable increases in efficiency.

Table 33. Measures/Technologies Predicted to Increase in Efficiency

	Residential		Business		Industrial	
Measures	Next 5 Years	Next 10 Years	Next 5 Years	Next 10 Years	Next 5 Years	Next 10 Years
LEDs	3	2	7	5		
Insulation	3		1			
Water Heaters	3	2				
Furnaces	2	1				
HVAC	4	3	2			
Air Sealing	2					
Boilers	2					
Appliances	1	1				
EMS/Controls		1	3	1		
Storage Technology				2		

Source: Navigant Market Actor Surveys 2016; n=26; Multiple responses accepted. Table provides count of mentions by market actors. Measures with no more than one response have been omitted from this table, but are presented in Appendix D.

Finally, taking into account current awareness and expected changes to price and efficiency, Navigant asked market actors to share their predictions for which measures or technologies would increase the most in adoption over the next five years. Once again, market actors working in Xcel Energy's Colorado territory expect to see widespread adoption of LED bulbs and HVAC technology, followed by lighting controls, Solar PV technology, and VFD. The Alternative Lighting Scenario presented in Section 5.3.4 provides discussion on the factors currently driving LED versus CFL adoption and how the potential for lighting energy efficiency may change if this widespread adoption occurs, despite the higher cost of LEDs relative to CFLs.

Table 34. Measures/Technologies Predicted to Increase Most in Adoption over the Next Five Years

Measure	Mentions
LED	12
HVAC	6
Lighting Controls	4
Solar PV	4
VFD	3
Wind	2
VRF	2
Ductless Mini-Splits	2
Storage	2
Permanent Magnet Motors	2

Source: Navigant Market Actor Surveys 2016; n=26; Multiple responses accepted. Table provides count of mentions by market actors. Measures with no more than one response have been omitted from this table, but are presented in Appendix D.

5.5 Benchmarking the Results

As part of this study, Navigant benchmarked levels of electric and gas achievable potential relative to two main sources. First, Xcel Energy's specific DSM program budgets and savings impacts reported to stakeholders and regulators were reviewed and assessed for consistency between historical budgets and savings and projected budgets and savings for this study. Second, a review and comparative analysis was conducted based on other DSM potential studies conducted in the region.

5.5.1 Review of Xcel Energy Historical DSM Accomplishments

Table 35 provides a comparison between the 2015 historical accomplishments and the 2018 forecasted Reference Scenario achievable potential energy savings and incentive expenditures. The table provides the comparison to the 2015 historical accomplishments on a percentage basis. As such, the figures in the table are relative to the 2015 historical data. Historical accomplishment data were derived from data provided to Navigant from Xcel Energy.

Table 35. Comparing Achievable Potential Forecast Results to Historical Accomplishments

	Electric Forecast Percent of Historic	Gas Forecast Percent of Historic
Incentive Expenditure		
Residential	88%	146%
Commercial	113%	202%
Industrial/Ag	36%	97%
Total	102%	
Energy Savings		
Residential	98%	123%
Commercial	93%	78%
Industrial/Ag	124%	117%
Total	98%	112%

Source: Navigant analysis, 2016

Overall, the electric portfolio for the Reference Scenario is generally in line with historical accomplishments. For gas, it will take more than 50 percent greater amount of incentives to achieve 12 percent greater savings relative to historical accomplishments. Several sector-specific observations can be made based on the comparison:

- For residential electric, it appears that the projected energy savings in 2018 is nearly in line with the historic accomplishments at 98 percent. Incentives paid for those savings can be done for 88 percent of the historic value. This seemingly counter-intuitive result might be explained based on a number of factors. First, there are still opportunities for relatively inexpensive DSM measures such as CFLs to be deployed before federal standards make those measures the baseline in 2020. Second, one measure with a fairly large savings potential for residential electric is Home Energy Reports, which can be done fairly inexpensively for a significant portion of residential customers.
- For the commercial electric, the projected energy savings and incentive expenditures in 2016 are slightly lower than the historical savings. However, the incentive expenditures are slightly higher at 113 percent. This finding might have to do with the fact that it will cost relatively more money to achieve the additional savings opportunities for commercial electric measures. A second factor might relate to lower electric avoided costs, which mean that fewer measures are able to pass through the economic screen than in the past thus leading to lower achievable potential perhaps for a higher cost than what has been seen in the recent past.
- For the industrial electric, the projected energy savings are 24 percent higher than what was experienced by Xcel Energy in their industrial programs for a cost that is significantly lower at 36 percent of historical. This suggests that the there is a significant amount of cost-effective electric savings still remaining in the Xcel Energy service territory to be harvested. However, there can often be a difference between what is theoretically achievable and what is actually achieved in practice.
- For gas, the projected energy savings in 2018 are 12 percent and 18 percent below the historic values, respectively. It appears that both the residential and commercial sectors generally follow this trend. Industrial savings and incentives expenditures tend to be in line with historical accomplishments.

5.5.2 Review of Other DSM Potential Studies

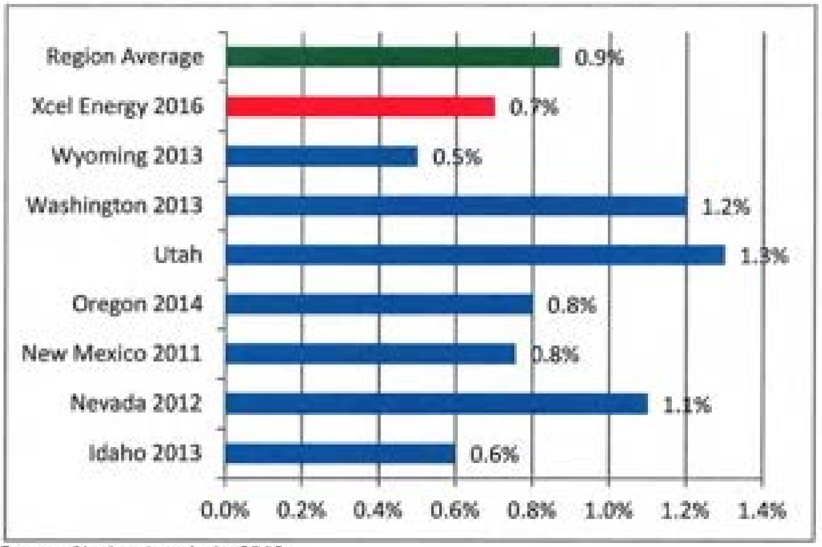
For the purpose of comparison, Navigant utilized data from various recent studies and limited comparison points to other recent potential studies conducted in a similar manner to that was conducted in this study. This was done in order to obtain to the extent possible an "apples to apples" comparison. Benchmark assessments are often instructive in that they can highlight whether the results of the Potential Study might be considered in the realm of what other studies in the region revealed. Also, the benchmarking can rapidly highlight whether the results of the Potential Study are an outlier relative to the other studies assessed. Note however that each study will have different driving assumptions – different sets of avoided costs, different forecasts, etc. – all suggesting that the benchmark can't be a true "apples to apples" comparison. As such, results should be taken as indicative rather than definitive.

Figure 55 provides a comparison of the electric annual average percentage reduction from this study (savings relative to net sales) compared to seven other studies from the region conducted over the past five years.[38] As can be seen, the result of this study appears to show mid funding achievable savings on the lower side relative to the other studies at 0.7 percent (average yearly reduction over the 11-year time horizon). For additional context, a regional average percent savings was calculated. The regional average of the seven studies, plus this one, indicate a 0.9 percent average annual reduction, which is about 20 percent higher than what was found in this study. While it is difficult to know precisely why the figures from this study are significantly lower than the average for the region, there a few driving factors that might explain the differences:

- All of the other studies report maximum achievable potential. Comparisons are made to the Reference Scenario from this study, which explains in part why the comparative values are consistently higher.
- All of the other studies were completed at least 2 years ago. At that time, avoided costs were higher which means that more measures likely passed the economic screens in those studies and thus the achievable potential was higher.
- The effects of federal equipment standards were not playing as significant a role for the other studies, given that those standards would not have gone into effect for several years. In this study, codes and standards were influencing the achievable results from the beginning of the 11-year forecast horizon, which had the effect of reducing the savings.

[38] US Department of Energy, Energy Efficiency Potential Study Catalog. The catalog is a compilation of state and local energy efficiency potential studies published since 2007. http://energy.gov/eere/slsc/energy-efficiency-potential-studies-catalog#catalog

Figure 55. Benchmarking of Electric Achievable Potential Savings

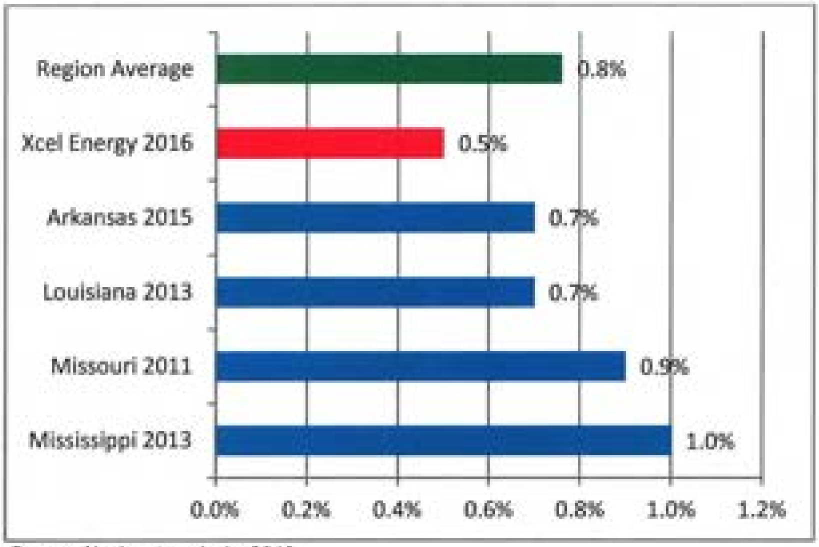


Source: Navigant analysis, 2016

Figure 56 provides a comparison of the gas annual average percentage reduction from this study (savings relative to net sales) compared to four other studies from outside the region conducted over the past four years.[39] Note that it was not possible to locate results from any gas potential studies recently conducted in the mountain region. As can be seen, the Xcel Energy 2016 study (this study) also appears to show achievable savings on the lower side relative to the other studies at 0.5 percent. For additional context, a regional average percent savings was calculated. The regional average of the four studies, plus this one, indicate a 0.8 percent average annual reduction, which is 35 percent higher than what was found in this study.

[39] ACEEE. "Cracking the TEAPOT: Technical, Economic, and Achievable Energy Efficiency Potential Studies." August 2014. Data in the figures below were derived from Table 2 of this study.

Figure 56. Benchmarking of Gas Achievable Potential Savings



Source: Navigant analysis, 2016

6. CONCLUSIONS

This study has resulted in updated, expanded, and improved information on the Xcel Energy customer base and the potential for energy reductions that are possible through DSM programs and initiatives. While much DSM potential exists, there are unique challenges that the Xcel Energy faces in its Colorado service territory in realizing this potential:

Prior DSM Success: Xcel Energy has effectively implemented DSM programs in the Colorado service territory for many years, often exceeding goals in terms of the amount of savings achieved at some, but not all segment levels within its energy efficiency portfolio. As greater levels of DSM are implemented in the service territory and market saturation increases it will become more challenging to harvest additional savings that are represented in the DSM potential. One example of this includes residential bathroom faucet aerators, where the study results show that savings will begin to level out around 2021 as the market reaches saturation for that measure.

Xcel Energy's past experiences with DSM program implementation also suggest that some measures, while cost effective opportunities at face value, have market barriers that limit customer adoption. The achievable potential presented here reflects those learnings, with market adoption tailored for certain measures like central air conditioning tune-up and advanced power strip measures that have historically had limited customer uptake in Xcel Energy's programs. The Advanced Lighting scenario similarly reflects the expectation that customer adoption of CFL lighting will be limited by customer technology preferences, despite the relative cost effectiveness of CFLs over LEDs.

Codes and Standards: The challenge of continuing to capture energy efficiency DSM savings within an increasingly saturated market is exacerbated by tightening codes and standards. In particular the federal EISA lighting standards have a large impact on energy efficiency DSM potential. A significant proportion of Xcel Energy's DSM portfolio has historically consisted of residential lighting savings, which will be substantially diminished once the EISA lighting standard changes. Codes and standards changes will also impact the savings available from measures such as commercial ice makers, Energy Star clothes washers, and a variety of commercial HVAC measures over the study period, with diminished savings available from these measures, as well.

Increasing Costs: Changes to the portfolio measure mix that occur due to market saturation and codes and standards changes drive costs upward, with the EISA lighting standard driving the most significant increases in program delivery costs over the study period. In the future, while Navigant forecasts incremental achievable savings potential to begin to decline around 2021, program acquisition costs continue to increase through the majority of the forecast horizon.

Fuel Mix: Xcel Energy serves its customers combined electricity and natural gas, electricity only, and natural gas only. While this is not generally a unique situation, the combination of fuel mixes adds complexity to the marketplace in terms of energy efficiency program delivery when targeting savings for each of these fuels separately, or in combination. These additional layers of complexity include appropriately capturing program savings, cost effectiveness, and incentives without double counting across fuel types and ensuring that incentives are distributed appropriately to single fuel customers.

Varied Regions within Xcel Energy Franchise Area: Xcel Energy has two very different regions in its territory: (1) the urban and suburban communities of Denver and Boulder where access to energy efficiency services is generally more favorable; and (2) the more rural locations located to the north of Denver (plains) and to the mountain west where delivery of energy efficiency services can be challenging. Due to the nature and diversity of customers in the Xcel Energy Colorado territory, achieving market acceptance and program participation is very challenging. Outreach, education and marketing to the numerous residential and business segments, as well as the highly variable market within each of these segments, must be a high priority in any DSM program effort.

It is recommended that updates to this DSM potential study be undertaken on a regular basis, with more granular analyses conducted for the important or promising markets for energy efficiency potential. These markets include:

- Commercial and industrial/ag buildings, which represent nearly 60 percent of the electric potential, show significant promise for improving the efficiencies of HVAC and lighting systems, particularly in new buildings. Because of the large potential Navigant sees in new construction, there could be opportunity for Xcel Energy to target this program for expansion, although additional research and/or program design efforts would be required to develop specific recommendations.
- Residential buildings (single family in particular) represent significant savings opportunities for electric cooling systems, gas space heating, lighting, and electronics end-uses. Targeting deep savings within this segment after the EISA implementation will be critical to meeting Xcel Energy's savings targets in the future.
- Single-family buildings present unique opportunities for capturing energy efficiency potential for both fuels (particularly natural gas) and nearly all end-uses, with the most promising opportunities for central cooling systems, central heating systems (electric and gas), and virtually all forms of lighting.

Further primary market research efforts could be geared toward a better understanding of customer decision making about DSM and their willingness to adopt DSM and at what price. Customer panels that would regularly check the pulse of customer attitudes could contribute toward making more meaningful mid-course corrections in program designs. Because the DSM market is dynamic, multi-dimensional and subject to continuous change, taking these and other measures is essential toward ensuring that energy savings are maximized in the most cost-effective manner.

APPENDIX A. OVERVIEW OF DSMSIM™ MODEL

The following slides from the Internal Stakeholder meeting in February 2016 (see Appendix F.1) provide an overview of the bottom-up technology diffusion and stock/flow tracking DSMSim™ potential model that Navigant used in this analysis.

DSM POTENTIAL MODEL

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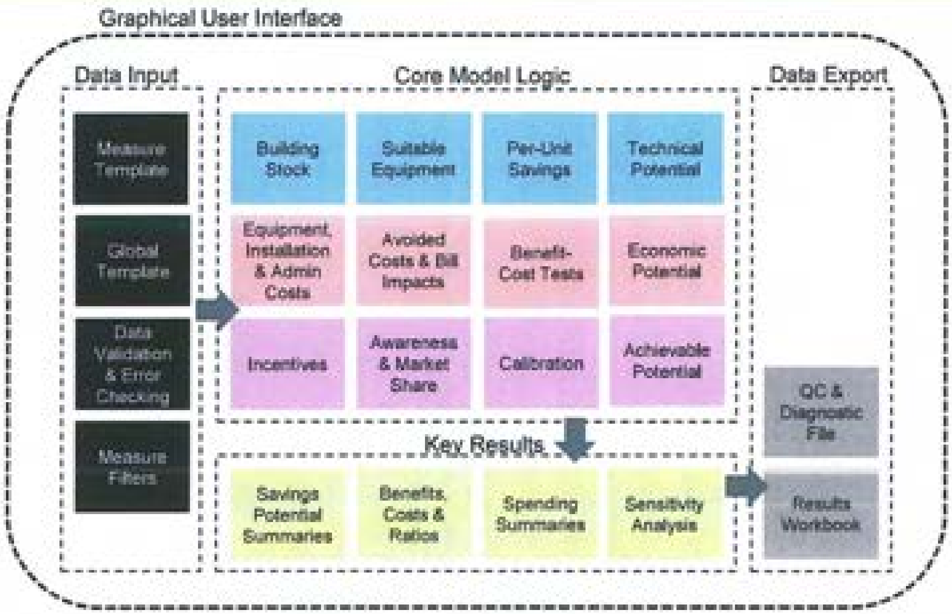
DSMSIM ARCHITECTURE



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INPUT TEMPLATES: EASY ACCESS TO KEY INPUT ASSUMPTIONS

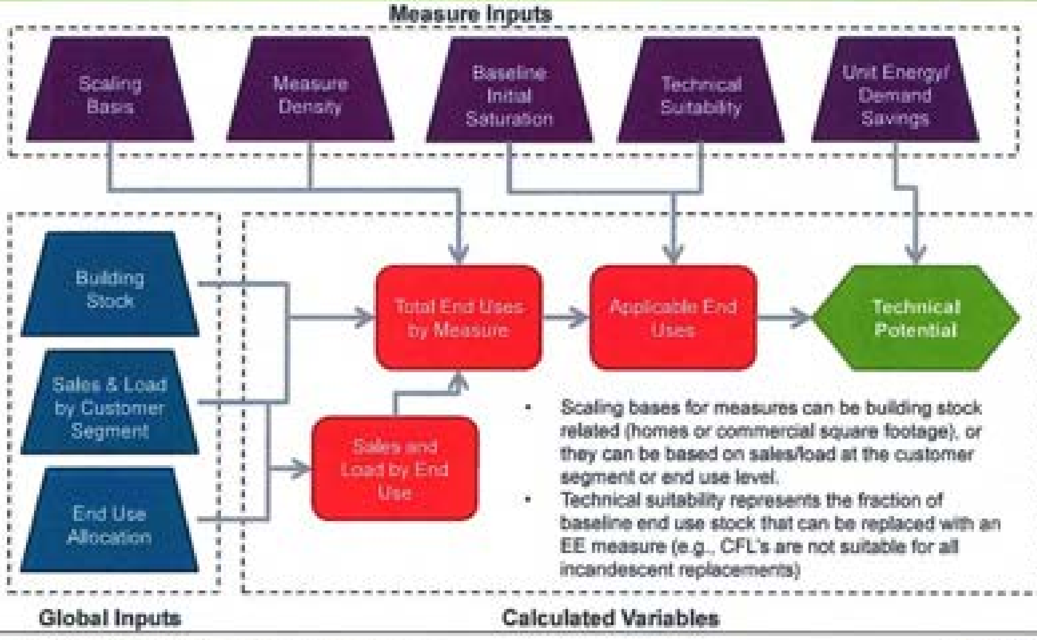
Measure Template

- Includes all measure-related input data
- 50+ measure characteristics
  - Incremental participant costs, consumption & demand, measure density, initial saturation, scaling basis, variable admin & load shape type
- Time-changing cost & consumption multipliers
- Data sources, descriptions & citations

Global Template

- Includes segment and service territory-specific data
  - Retail rates & avoided costs
  - Building stock forecasts
  - Sales and load forecasts with end use allocations
  - Load shape profiles
  - Discount rates, inflation rates & line losses
  - Program & portfolio admin costs

TECHNICAL POTENTIAL



- Scaling bases for measures can be building stock related (homes or commercial square footage), or they can be based on sales/load at the customer segment or end use level.
- Technical suitability represents the fraction of baseline end use stock that can be replaced with an EE measure (e.g., CFL's are not suitable for all incandescent replacements)

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ECONOMIC POTENTIAL

- Economic potential is the subset of technical potential that meets some cost-test screening threshold.
- Screening thresholds can differ by measure, sector, end use, etc.
- Cost-test calculations follow standard practice and include:
  - Incremental participant costs
  - Avoided costs
  - Bill impacts
  - O&M costs/savings
- Costs and benefits are calculated over the measure life or over a user-specified horizon
- Can choose whether avoided costs from secondary savings will be included
  - E.g., for an insulation program for electric-only customers (cooling savings), could Xcel Energy claim avoided gas costs (heating savings)?

NAVIGANT Xcel Energy DSM Potential Study

COMPETITION GROUPS

- Measures competing for the same end use savings are lumped into competition groups to prevent double-counting of savings potential (e.g., high efficiency water heaters and heat pump water heaters).
- Competing technologies share the same baseline assumptions and baseline measure densities.
- Competition can only occur within a given customer segment, replacement type, and service territory (service territories are differentiated by fuel-type *and* climate zone).
- For technical and economic potential, only the measure with the greatest potential within the competition group is included in the reported totals.
  - For economic potential, no consideration for the most economic competing measure is made other than the requirement that it pass the cost-test screening threshold.

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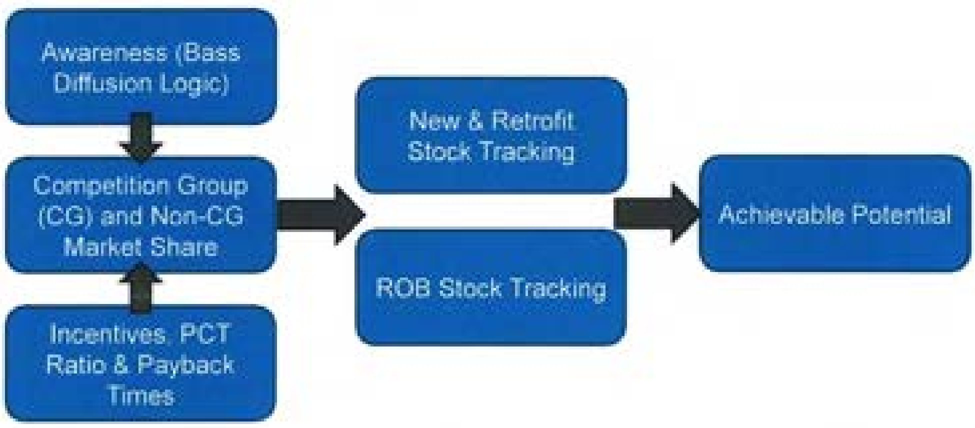
ACHIEVABLE POTENTIAL

Achievable potential is calculated by modeling market mechanisms, participant interaction, measure attractiveness and stock turnover dynamics



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Xcel Energy DSM Potential Study

INCENTIVE METHODS

Percentage of Incremental Costs [%]	• Incentives calculated to be a specified percentage of the incremental costs • Equitable in relative terms
Targeted Payback Period [years]	• Incentives calculated to produce a specified payback period for the participant • Equitable in absolute terms and promotes comprehensiveness
Targeted Participant Cost [level. $/kWh]	• Incentives calculated to produce a specified levelized cost for the participant • Equitable in absolute terms
Max Utility Incentive [level. $/kWh]	• Incentives calculated as the minimum of the measure's levelized cost or the specified max incentive threshold • Focus is minimizing acquisition costs and has the byproduct of maximizing lifetime savings (i.e., persistence)

All strategies can be differentiated by customer segment or end use, and all strategies apply a minimum incentive as a percentage of incremental costs

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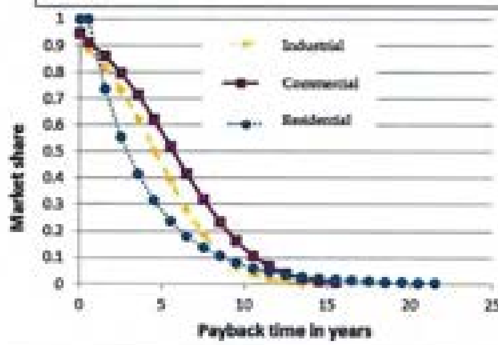
MARKET SHARE

- Among competing efficient measures
  - Relies on a logit formulation for simulating discrete choice of competing EE measures.
  - PCT ratio is the main driver for participant's selection among EE measures.
  - Logit market share is used to determine a weighted simple payback for entire competition group.
- Among EE and baseline measures
  - Relies on payback acceptance curves empirically based on Navigant-led participant surveys.
  - Competition groups treated as single EE measure to determine total EE market share, which is then re-distributed to competing measures based on logit market share.
  - Payback adders (positive or negative) can be applied for calibration to observed acceptance levels.

$$CGMarketShare = \frac{e^{PCT_m * sensParam}}{\sum_m e^{PCT_m * sensParam}}$$

- *CGMarketShare* = competition group market share
- *PCT* = participant cost test ratio
- *sensParam* = sensitivity to differences in PCT
- *m* = competing measure



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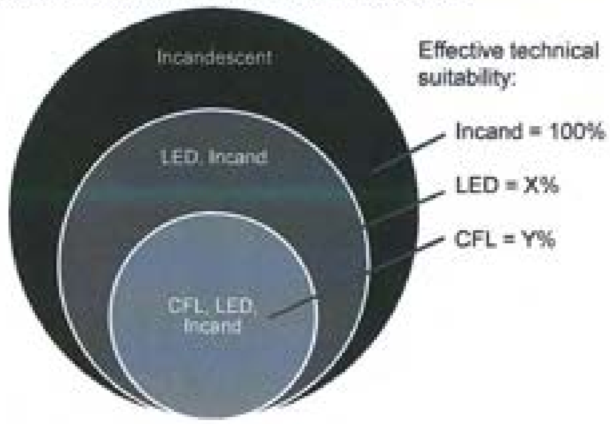
NESTED COMPETITION FOR MARKET SHARE

- Competition group measures compete for nested subsets of the suitable end use opportunities.
- The size of each subset is a function of each measure's "effective technical suitability", which is the minimum of awareness or technical suitability.
- The calculated market share for each subset is multiplied by the incremental area of the subset to determine a weighted average market share across all subsets.

Nested Competition Among Lighting Measures



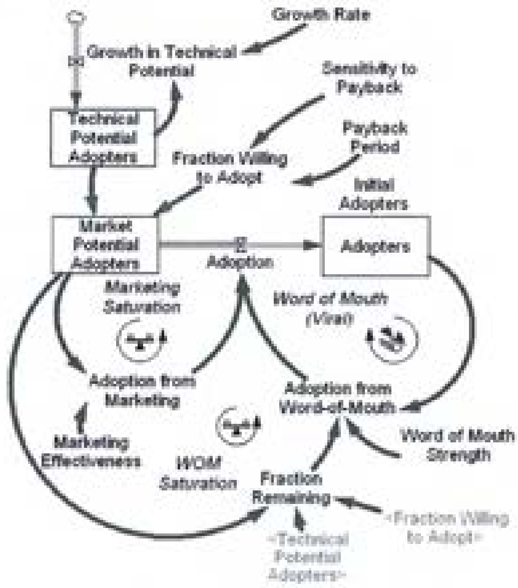
Area represents the fraction of end use opportunities (e.g., sockets) that are suitable for each competing EE measure and for the baseline measure (100% suitable)

NAVIGANT

Xcel Energy DSM Potential Study

STOCK-AND-FLOW DIAGRAM: NEW AND RETROFIT MEASURES

- New Construction
  - Upper bound on EE opportunities limited by growth in building stock.
  - Awareness (s-shaped bass diffusion) limits market adoption when low.
- Retrofit
  - Upper bound on EE opportunities limited by awareness (s-shaped bass diffusion).
  - Assume initial awareness is low to prevent retrofit of entire stock.



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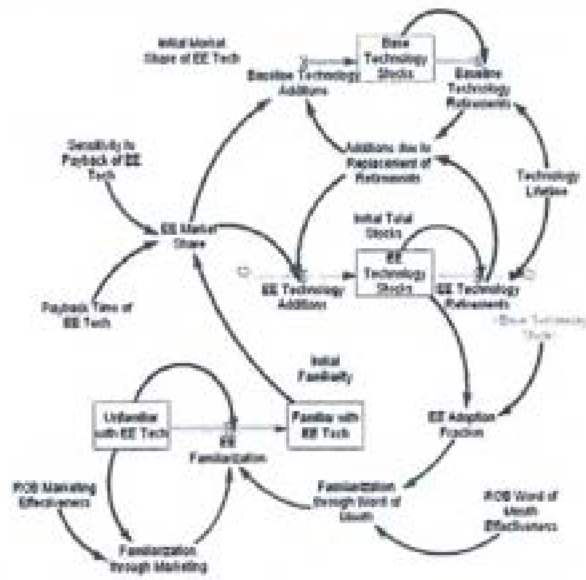
STOCK-AND-FLOW DIAGRAM: ROB MEASURES

- Upper bound on EE opportunities limited by measure turnover.
  - Measure turnover dictated by measure lifetime exponentially distributed.
- Awareness (s-shaped bass diffusion) limits market share when low.



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ACHIEVABLE POTENTIAL CALIBRATION

- A typical calibration process includes calibrating the first several simulation years to historic levels or industry averages of savings potential and acquisition costs.
- A secondary calibration shapes the calculated budget over time to reflect regulatory environments or spending targets.
- Lastly, sensitivities provide insight into savings potential at different budget levels.

Calibrated Results

- Initial savings potential
- Initial total spending
- Total spending over time
- Initial acquisition costs
- By sector, end use, and total

Calibration Levers

- Incentives (four approaches)
- Bass diffusion parameters
  - Marketing factors
  - Word-of-mouth factors
  - Initial awareness
- Cost-test screening threshold
- Payback adders

APPENDIX B. RESIDENTIAL SURVEY RESULTS

This appendix includes the final survey instrument used for the residential online survey, as well as the final residential survey results.

B.1 Survey Instrument

Xcel Energy Residential On-Line Survey

— PROGRAMMED —

March 2, 2016

SURVEY OBJECTIVES:

1. Determine home type, size, age, occupancy, usage patterns, and demographics
2. Characterize the residential market in Xcel Energy's Colorado service territory
3. Determine major equipment efficiency levels

Table B-1: Xcel Residential Baseline On-Line Survey Topics

Topics	Research Questions
Features of the home	• Square feet of home • % Heated square feet • % Air conditioned square feet • Age of home
Space Heating	• Heating system in home • Type of heating system • Efficiency of heating system • Age of heating system • Thermostat type
Air conditioning	• Cooling system in home • Type of cooling system • Efficiency of cooling system • Age of cooling system • Thermostat type
Water heating	• Energy source • Type of water heating system • Efficiency of water heating system • Age of system
Major appliances	• How many in home – Refrigerators, Freezers, Cooking equipment, Dishwashers, Clothes washers and Clothes dryers. • Energy star rated or High efficiency
Miscellaneous Electronics	• How many in home – Televisions, Set-top boxes, Game consoles, Desktop PC's, Laptops, advanced power strips etc. • How many Energy Star or High Efficiency
Demographics	• Type • Income level

Introduction

We at Xcel Energy is asking for your help to understand Colorado-specific residential energy use and customer decision-making for energy efficiency. Your responses will help us improve energy efficiency programs that assist residential customers in saving energy and money, and ultimately, benefit the environment. This survey will take about 15 minutes.

All responses are strictly confidential and will be used for research purposes only; they will not be associated in any way with you or your home.

About Your Home

First, we would like to ask you a few questions about your home at <ADDRESS> [ADDRESS SHOULD BE PREMISE ADDRESS LISTED IN THE SAMPLE]

1. Does your household pay for natural gas or electric service provided by Xcel Energy?(Select one response)
   01. Natural gas service ONLY
   02. Electric service ONLY
   03 Natural gas AND electric service
   04. Do not pay for electric or natural gas service, included in rent or use other energy sources
   99. Don't know

IF 04 OR 99 TERMINATE – GO TO THANK YOU AND TERMINATE.

2. Which of the following best describes your home? (Select one response)
   01. Single family (detached or attached)
   02. Multi-family (low- or high-rise apartment building)
   03. Manufactured, modular or mobile home
   99. Don't know

IF 01-03 QUALIFY. IF 99 GO TO THANK YOU AND TERMINATE.

3. Is this home your main residence, a weekend residence, or seasonal/vacation residence? (Select one response)
   01. Main Residence
   02. Weekend Residence
   03. Seasonal/Vacation Residence
   88. Other (please specify)
   99. Don't know

IF 01, QUALIFY. 02 TO 99 GO TO THANK YOU AND TERMINATE.

4. Approximately how large is your home in square feet? Please do not include garages or unfinished basement space. (Select one response)
   01. Less than 1,000 square feet
   02. 1,000 to less than 1,500 square feet
   03. 1,500 to less than 2,000 square feet

04. 2,000 to less than 2,500 square feet
05. 2,500 square feet or more
99. Don't know

5. Approximately what percent of your home's square footage is heated? (Select one response)
    01. Less than 25%
    02. 25% to less than 50%
    03. 50% to less than 75%
    04. 75% to less than 100%
    05. 100%
    99. Don't know

6. Approximately what percent of your home's square footage is air conditioned? (Select one response)
    01. Less than 25%
    02. 25% to less than 50%
    03. 50% to less than 75%
    04. 75% to less than 100%
    05. 100%
    99. Don't know

7. Approximately, when was your home constructed?

01	Before 1960	
02	1960-1969	
03	1970-1979	
04	1980-1989	
05	1990-1999	
06	2000-2005	
07	2006-2010	
08	2011 or later	
88	Prefer not to answer	
99	Don't know	

8. What type of windows are currently installed in your home? (Select one response)
    01. Single pane (one pane of glass)
    02. Single pane with storm windows
    03. Double pane (two panes of glass)
    04. Triple pane (three panes of glass)
    05. Other
    99. Don't know

9. Have insulation levels in your home been upgraded since the home was built?
    01. Yes
    02. No
    99. Don't know

Space Heating

Next, we would like to ask some questions about how you heat your home.

10. What is the main heating system used to heat your home? (The one used most often) (Select one response)

01	Forced air furnace	
02	Electric baseboard heat	
03	Individual room heaters	
04	Heat pump	
05	Boiler / steam or hot water system	
06	Electric thermal storage	
07	Wood or pellet stove, fireplace, or furnace	
08	Solar	
77	Other (please specify)	
88	Prefer not to answer	
99	Don't know	

11. Would you characterize this heating equipment as standard efficiency or high efficiency?

01	Standard efficiency	
02	High efficiency	
88	Prefer not to answer	
99	Don't know	

12. Do you know the actual efficiency rating of the heating equipment?

01	Yes	
02	No [GO TO Q14]	
88	Prefer not to answer [GO TO Q14]	
99	Don't know [GO TO Q14]	

IF Q12 = YES GO TO Q13, ELSE GO TO Q14

13. Please record the efficiency rating of the heating equipment, including the rating unit:

    a. Rating _____ [NUMERIC]

    b. Rating Unit: [DROP DOWN]

        1. AFUE

        2. COP

        3. Other unit (please specify)

14. How old is your main heating system (in years)? (If you aren't sure please estimate.) [NUMERICAL OPEN END (RANGE 0-100)] Age in Years ___ (Enter 0 if less than six months, enter 1 if six months to one year)
    99. Don't know

15. Is your heating system controlled by a thermostat?

01	Yes	
02	No [GO TO Q17]	
88	Prefer not to answer [GO TO Q17]	
99	Don't know [GO TO Q17]	

16. What type of thermostat is used to control the heating system? (Select one response)

01	Standard thermostat	
02	Programmable thermostat	
03	Smart/Wi-Fi thermostat	
77	Other (please specify)	
88	Prefer not to answer	
99	Don't know	

Air Conditioning

The next questions are about cooling your home.

17. Do you cool your home in the summer time using a cooling system?
    01. Yes
    02. No [GO TO Q26]
    99. Don't know [GO TO Q26]

IF NO OR DON'T KNOW, SKIP TO WATER HEATING SECTION – Q26

18. Does the cooling system for your home serve more than one residence?
    01. Yes
    02. No
    99. Don't know

19. What is the main cooling system used to cool your home? (Select one response)

01	Central air conditioning (with cooling ducts to different rooms)	
02	Window-, room-, or wall-mounted air conditioners	
03	Heat pump	
04	Ceiling fans	
05	Portable fans	
06	Evaporative (swamp) cooler	
77	Other (please specify)	
88	Prefer not to answer	
99	Don't know	

20. Would you characterize this cooling equipment as standard efficiency or high efficiency?

01	Standard efficiency	
02	High efficiency	
88	Prefer not to answer	
99	Don't know	

21. Do you know the actual efficiency rating of the cooling equipment?

01	Yes	
02	No [GO TO Q23]	
88	Prefer not to answer [GO TO Q23]	
99	Don't know [GO TO Q23]	

IF Q21 = YES GO TO Q22, ELSE GO TO Q23

22. Please record the efficiency rating of the cooling equipment, including the rating unit:

a. Rating _____ [NUMERIC]

b. Rating Unit: [DROP DOWN]

1. SEER
2. HPSF
3. Other unit (please specify)

23. How old is your main cooling system (in years)? (If you aren't sure please estimate.)
NUMERICAL OPEN END [RANGE 0-98] Age in Years ___ (Enter 0 if less than six months, enter 1 if six months to one year)
99. DON'T KNOW

24. Is your cooling system controlled by a thermostat?

01	Yes	
02	No [GO TO Q26]	
88	Prefer not to answer [GO TO Q26]	
99	Don't know [GO TO Q26]	

25. What type of thermostat is used to control the cooling system? (Select one response)

01	Standard thermostat	
02	Programmable thermostat	
03	Smart/Wi-Fi thermostat	
77	Other (please specify)	
88	Prefer not to answer	
99	Don't know	

Water Heating

The next questions are about your home's water heating system.

26. Does the water heating system for your home serve more than one residence?
01. Yes
02. No
99. Don't know

27. What type of fuel is used to heat your water? (Select one response)
    01. Electricity
    02. Natural gas
    03. Propane
    04. Solar
    88. Other (please specify) __________
    99. Don't know

28. What type of water heater do you use in your home? (Select one response)

01	Storage tank (the most common type of water heater)	
02	Instant or tankless water heater(s)	
03	Heat pump water heater	
77	Other	
88	Prefer not to answer	
99	Don't know	

29. Would you characterize this water heating equipment as standard efficiency or high efficiency?

01	Standard efficiency	
02	High efficiency	
88	Prefer not to answer	
99	Don't know	

30. Do you know the actual efficiency rating of the water heating equipment?

01	Yes	
02	No [GO TO Q32]	
88	Prefer not to answer [GO TO Q32]	
99	Don't know [GO TO Q32]	

IF Q30 = YES GO TO Q31, ELSE GO TO Q32

31. Please record the efficiency rating of the water heating equipment, including the rating unit:

    a. Rating _____ [NUMERIC]

    b. Rating Unit: [DROP DOWN]

        1. EF
        2. ET
        3. Other unit (please specify)

32. How old is your water heater system (in years)? (If you aren't sure please estimate.)
    NUMERICAL OPEN END [RANGE 0-98] Age in Years ___ (Enter 0 if less than six months, enter 1 if six months to one year)
    99. DON'T KNOW

Major Appliances and Electronics

This section asks questions about major appliances used in your home.

33. For each of the following appliances, please tell us:
    a. How many are in use in your household
    b. How many are Energy Star Rated or High Efficiency
    c. Average age of the appliance(s)

	Major Appliances	**a. Number of appliances used in your home** ***(enter 0 if none)***	**b. Number of Energy Star or high efficiency** ***(enter 0 if none)***	**c. Average age of appliance(s) (in years)** ***(enter 0 if less than six months, enter 1 if six months to one year)***
01	Refrigerator			
02	Freezer – standalone			
03	Electric Range/Cooktop – Coil or Flat			
04	Induction Cooktop			
05	Natural Gas Range/Cooktop			
06	Conventional or Convection Oven			
07	Combination Oven			
08	Microwave			
09	Dishwasher			
10	Clothes Washer			
11	Clothes Dryer			
88	Prefer not to answer			
99	Don't know			

34. For each of the following electronics, please tell us:
    d. How many are in use in your household.
    e. How many are Energy Star Rated or High Efficiency.
    f. Average age of electronic(s)

	Miscellaneous Electronics	a. Number of electronics used in your home *(enter 0 if none)*	b. Number of Energy Star or high efficiency *(enter 0 if none)*	c. Average Age of electronic(s) (in years) *(enter 0 if less than six months, enter 1 if six months to one year)*
01	Televisions – Standard			
02	Televisions – Plasma			
03	Televisions – LCD			
04	Televisions – LED/LCD less than 3 years			
05	Cable set top boxes			
06	DVD Player or DVR			
07	Video Game Systems (X, Wii, etc.)			
08	Desktop PC (personal computer) or Server			
09	Laptops or notebooks			
10	Computer monitors			
11	Sound bars			
12	Advanced power strips			
88	Prefer not to answer			
99	Don't know			

Demographics

Lastly, we just have a few final questions about your household.

35. Do you own or rent your home? (Select one response)
    - 01. Own
    - 02. Rent
    - 77. Other arrangements (please specify)
    - 88. Prefer not to answer
    - 99. Don't know

36. Counting yourself, how many people live in your home for most of the year? (Select one response)
    - 01. (1) Person
    - 02. (2) People
    - 03. (3) People
    - 04. (4) People
    - 05. (5) People
    - 06. (6) People
    - 07. (7) People
    - 08. (8) or more people
    - 88. Prefer not to answer
    - 99. Don't know

37. Which category best describes your total household income in 2015 before taxes? (Select one response)
    01. Less than $15,000
    02. $15,000 to less than $20,000
    03. $20,000 to less than $30,000
    04. $30,000 to less than $40,000
    05. $40,000 to less than $50,000
    06. $50,000 to less than $75,000
    07. $75,000 to less than $100,000
    08. $100,000 to less than $150,000
    09. $150,000 or more
    88. Prefer not to answer
    99. Don't know

Thank You & Terminate

Thank you for taking the time to complete the survey. Xcel Energy is planning to visit a few customer homes to gather more information on energy efficiency equipment. The visit would be complimentary and might provide you with information on how to increase the efficiency at your home. Would you be interested in a phone call to discuss participating?

01	Yes	
02	No	
88	Prefer not to answer	
99	Don't know	

IF above answer is 01 (YES),
Please provide the best contact number to reach you.
(ACCEPT PHONE NUMBER) __________

That's all the questions that we have. Thank you very much for taking the time to participate in this study.

B.2 Detailed Survey Results

See attachment, "Xcel Energy_2016 DSM Potential Study Complete Crosstabs_11-01-16.xlsx," for the final residential survey results, which incorporate the results from both the online and onsite surveys.

APPENDIX C. COMMERCIAL AND INDUSTRIAL SURVEY RESULTS

This appendix includes the final survey instrument used for the C&I phone survey, as well as the final C&I survey results.

C.1 Survey Instrument

Xcel Energy Commercial, Industrial and Agricultural Telephone Survey
— FINAL —
February 12, 2016

SURVEY Objectives:

1. Determine facility type, size, age, occupancy, usage patterns, and firmographics
2. Characterize the commercial, industrial and agricultural markets in Xcel Energy's Colorado service area
3. Determine major equipment saturations

Introduction

Hello, my name is <INTERVIEWER NAME>, and I'm calling on behalf of Xcel Energy.

May I speak with the person most knowledgeable about the cooling, heating, and lighting equipment at your business's facility at <SERVICE ADDRESS> in <SERVICE CITY>?

1 Yes
2 No [attempt to convert]

INTRO1
I'm with Tetra Tech, an independent research firm. We have been hired by Xcel Energy to talk with some of their customers about your thoughts regarding energy use to help enhance and improve Xcel Energy's commercial, industrial and agricultural energy efficiency programs.

I'm not selling anything; I'd just like to ask your opinions to help Xcel Energy develop new programs and improve existing programs for customers. We would like to understand how customers operate facilities like this one, and what types of energy-using equipment you have. All responses are strictly confidential and will be used for research purposes only. Information you provide will not be directly associated with your organization. Your input to the study is very important.

Before we start, I would like to inform you that for quality control purposes, this call will be recorded and monitored.

(Who is doing this study: Xcel Energy—they have hired our firm to investigate how customers operate facilities like this one, and what types of energy-using equipment you have.)

(**Why are you conducting this study**: This study is critical to help Xcel Energy better understand customers' need for and interest in energy efficiency programs and services and help improve on existing offerings.)

(**Timing**: This survey should take about 20 minutes of your time. [Interviewer: If now is not a good time, set up call back appointment or offer to let them call us back at 1-800-454-5070])

(**Sales concern**: I am not selling anything; all responses are strictly confidential and will be used for research purposes only. Information you provide will not be directly associated with your organization. If you would like to talk with someone from Xcel Energy about this study, feel free to call <LOUISE WOOD at 303-294-2502>.)

INTRO2 Are you the person most knowledgeable about the cooling, heating, and lighting equipment at this facility?

01	Yes (SKIP TO Q1)	
02	No (ASK INTRO3)	

INTRO3 Who else at your firm would be more knowledgeable about your cooling, heating, and lighting equipment at this location? May I please speak with that person?

01	Yes (SPECIFY NAME AND RESTART SURVEY AT INTRO1 WI THIS NEW RESPONDENT)	
02	No (THANK AND TERMINATE)	
03	Don't know (THANK AND TERMINATE)	

1. Does your business pay Xcel Energy for natural gas service, electric service, or both natural gas and electric service?

01	Natural gas service ONLY	
02	Electric service ONLY	
03	Natural gas AND electric service	
04	Neither, included in rent or use other energy sources	Thank and terminate
88	Refused	Thank and terminate
99	Don't know	Thank and terminate

2. What is your job title?

01	Facilities Manager	
02	Building Manager	
03	Energy / Sustainability Manager	
04	Other facilities management/maintenance position	
05	Chief Financial Officer	
06	Other financial/administrative position	

07	Proprietor/Owner	
08	President/CEO	
77	Other (record verbatim)	
88	Refused	
99	Don't know	

Firmographics

I'd like to start by asking you a few questions about the general characteristics of your organization's facility at <SERVICE ADDRESS> in <SERVICE CITY>.

3. Would you describe your business activity as mainly commercial, mainly industrial or mainly agricultural at <SERVICE ADDRESS>?

01	Mainly commercial	
02	Mainly industrial	
03	Mainly agricultural	
88	Refused	
99	Don't know	

ASK IF Q3 = 1; ELSE SKIP TO Q8

4. What type of commercial business activity is conducted at <SERVICE ADDRESS>? [READ LIST] [SINGLE RESPONSE ALLOWED]

01	Office	
02	Retail (non-food)	
03	College/university	
04	School	
05	Grocery store	
07	Restaurant	
08	Health care/hospital	
09	Hotel or motel	
10	Warehouse (Refrigerated or Non-refrigerated)	
14	Multi-Family Residential/Apartment Facility	Thank and Terminate
77	Other (record verbatim)	
88	Refused	
99	Don't know	

5. Is this a home-based business operated out of your residence?

01	Yes (IF YES GO TO THANK YOU & TERMINATE)	
02	No	
99	Don't know	

IF Q5 = 2, CONTINUE; ELSE SKIP TO THANK AND TERMINATE

ASK IF Q3 = 2; ELSE SKIP TO Q8

6. What type of industrial business activity is conducted at <SERVICE ADDRESS>? [READ LIST] [SINGLE RESPONSE ALLOWED]

01	Chemical, Petroleum and Coal Products	
02	Computer and Electronics	
03	Electrical Equipment	
04	Appliance and Components	
05	Fabricated Metal Products	
06	Food, Beverage and Tobacco Products	
07	Furniture, Leather and Allied Products	
08	Machinery	
09	Plastics and Rubber Products	
10	Primary Metal and Nonmetallic Mineral Products	
11	Printing and Related Support Activities	
12	Textiles and Apparel	
13	Transportation Equipment	
14	Wood Products and Paper	
15	Aerospace	
16	Bioscience	
17	Data Centers	
18	Creative Industries	
77	Other (record verbatim)	
88	Refused	
99	Don't know	

ASK IF Q3 = 3; ELSE SKIP TO Q8

7. What type of agricultural business are you in? [READ LIST AND ACCEPT MULTIPLE RESPONSES]

01	Grains (Proso Millet, Corn, Wheat)	
02	Vegetables (Potatoes, Beans, Cabbage)	
03	Fruits (Peaches, Apples, Cantaloupe)	
04	Marijuana	
05	Cattle or sheep	
06	Dairy	
07	Poultry	
08	Sunflowers	
77	Other (record verbatim)	
88	Refused	
99	Don't know	

8. Approximately how many full-time employees does your business have at this location?

Numeric open end: ________________

9. Approximately how many part-time or seasonal employees does your business have at this location?

Numeric open end: ________________

10. Is your business's facility at this location... [READ]

01	A single, unattached building	
02	Two to five unattached buildings	
03	Six or more unattached buildings	
04	Part of a mall	
05	Part of a non-mall shared facility	
06	Part of a high-rise office building	
07	Part of a campus of facilities	
77	Other (record verbatim)	
88	Refused	
99	Don't know	

11. Approximately, when was this building constructed? Please provide your best estimation. [READ IF NECESSARY]

01	Before 1960	
02	1960-1969	
03	1970-1979	
04	1980-1989	
05	1990-1999	
06	2000-2005	
07	2006-2010	
08	2011 or later	
88	Refused	
99	Don't know	

12. What is the approximate floor area, in square feet, that is occupied by your business at this location? [READ IF NECESSARY]

01	Less than 1,000 square feet	
02	1,000 to less than 2,000 square feet	
03	2,000 to less than 3,000 square feet	
04	3,000 to less than 5,000 square feet	
05	5,000 to less than 10,000 square feet	
06	10,000 to less than 15,000 square feet	
07	15,000 to less than 25,000 square feet	
08	25,000 to less than 50,000 square feet	
09	50,000 to less than 100,000 square feet	
10	100,000 square feet or more	
88	Refused	
99	Don't know	

Next, I have a few questions about the hours of operation for your facility. We are interested in the hours the facility is operating, not necessarily business hours.

13. What is the average number of hours of operation Monday through Friday? (Enter 2400 for 24-hour operation, enter 0 for never operating)

01	Enter hours and minutes, e.g., 0930 for 9.5 hours	
88	Refused	
99	Don't know	

14. Does your facility operate on a different schedule on Saturday and Sunday than it does Monday thru Friday?

01	Yes	
02	No	
03	Not open at all on Saturday and Sunday	
88	Refused	
99	Don't know	

ASK IF Q14 = 1, ELSE SKIP TO Q16

15. What is the average number of hours of operation on Saturday through Sunday? (Enter 2400 for 24-hour operation, enter 0 for never on)

01	Enter hours and minutes, e.g., 1600 for 16.0 hours	
88	Refused	
99	Don't know	

16. Have the total number of hours of operations changed for your facility during the past 12 months?

01	Yes	
02	No	
88	Refused	
99	Don't know	

IF Q16 = 1 ASK Q17, ELSE SKIP TO Q18

17. Please describe the reason for the changes in operating hours. (RECORD VERBATIM)

Energy Management System Equipment

18. Does this facility have a centralized building control system, also known as an energy management system or a building automation system that discovers reports, and/or corrects undesired control issues? [If needed: A central energy management system is a computer-based control system that controls and monitors electrical equipment such as HVAC and/or lighting.]

01	Yes	
02	No	
88	Refused	
99	Don't know	

ASK IF Q18 = 1; ELSE SKIP TO NEXT SECTION [Q22]

19. What equipment at this facility is controlled by the "energy management system"? Does it control… [READ LIST AND ACCEPT MULTIPLE RESPONSES]

01	Lighting	
02	HVAC equipment	
03	Lighting & HVAC equipment	
04	Other (record verbatim)	
88	Refused	
99	Don't know	

20. When was this "energy management system" installed?

01	Less than 5 years ago	
02	5 to less than 10 years ago	
03	10 years ago or more	
88	Refused	
99	Don't know	

21. When was the "energy management system" last retro commissioned?

01	Never	
02	Within last year	
03	1 year to less than 2 years	
03	2 years to less than 5 years	
04	5 years ago or more	
88	Refused	
99	Don't know	

The next section of the survey is focused primarily on how electricity is consumed at your business's facility located at <SERVICE ADDRESS> in <SERVICE CITY>.

Outdoor Lighting

I would now like to ask you a few questions about your outdoor lighting equipment.

22. Does this facility have outdoor lighting that the business is responsible for? [if needed: those areas that are exposed to the open air such as parking lots, garages, porches, walk ways, playing fields, etc.]

01	Yes	
02	No (GO TO Q26)	
88	Refused (GO TO Q26)	
99	Don't know (GO TO Q26)	

23. I'm going to read a list of the most common types of outdoor lighting. For each type, I would like you to estimate the approximate percentage of the total outdoor lighting provided by that type of lighting at your facility. If you are not sure, give us your best guess. [READ LIST ONCE, THEN RE-READ LIST AND RECORD RESPONSES] What percent of your outdoor lighting is...? [READ LIST AND RECORD PERCENTAGES – SHOULD ADD TO 100%]

01	Fluorescent tubes	
02	Compact Fluorescent Lamps (CFLs)	
03	HID lamps (e.g. metal halide, mercury vapor, or high pressure sodium)	
04	Incandescent	
05	LED lights	
10	None	
77	Other (record verbatim)	
88	Refused	
99	Don't know	

ASK IF Q23_03 > 0, ELSE SKIP TO Q25

24. What type of HID lamps do you have installed in your facility? [READ LIST AND ACCEPT MULTIPLE RESPONSES]

01	Metal Halide	
02	Mercury Vapor	
03	High Pressure Sodium	
77	Other (record verbatim)	
88	Refused	
99	Don't know	

25. Now turning to the systems that control the lighting, which of these control systems do you have at this facility to control your outdoor lighting? [READ LIST AND ACCEPT MULTIPLE RESPONSES]

01	Manual switches	
02	Occupancy sensors	
03	Automated central controls such as an Energy Management System	
04	Automated central controls such as daylight sensors	
05	Automated central controls such as time clocks	
06	No control systems	
77	Other (record verbatim)	
88	Refused	
99	Don't know	

Space Cooling

IF Q3 = 1 THEN ASK Q26; ELSE SKIP TO NEXT SECTION

26. Now I'd like to ask you some questions about the cooling equipment. Approximately what percentage of the space occupied by your business is air-conditioned during the summer months? [READ IF NECESSARY]

01	100 percent	
02	75 to 99 percent	
03	50 to 74 percent	
04	25 to 49 percent	
05	One to 24 percent	
06	None [SKIP TO NEXT SECTION]	
99	Don't know	

27. What is the primary type of equipment used to cool this facility? Do you use <READ LIST>? [READ, SELECT ONE]

	Type of system	Yes/No
01	Central chilled water plant, where a large central cooling system is used to cool water that is then distributed to multiple locations	
02	Packaged central air conditioners, where the compressor, condenser, and supply air fan are contained in the same housing and located on the roof or on the ground outside of your building	
03	Split-system air conditioners made up of two components, where the compressor and condenser are located outside and the supply air fan is inside the building shell)	
04	Individual window or wall units, where all components located in same housing	
05	District Chilled water piped in from outside the building	
06	Mini-split heat pumps	
07	Ceiling fans	
77	Other (record verbatim)	
88	Refused	
99	Don't know	

IF Q27 = 1 OR 5 THEN ASK Q28; ELSE SKIP TO Q29.

28. What percentage of your facility's cooling is provided by packaged or split chillers, central chilled chillers, or district chilled chillers versus other types of cooling? (MUST ADD UP TO 100 PERCENT.)

01	Packaged or split systems (RECORD PERCENTAGE)	
02	Central Chilled Water Plant (RECORD PERCENTAGE)	
03	District Chilled Water Piped (RECORD PERCENTAGE)	
04	Other cooling (RECORD PERCENTAGE)	
88	Refused	
99	Don't know	

29. Can you provide the approximate SEER/EER rating of the cooling equipment? [RECORD IF YES]

01	Yes (RECORD and GO TO Q31)	
02	No (GO TO Q30)	
88	Refused (GO TO Q30)	
99	Don't know (GO TO Q30)	

30. Would you characterize the cooling equipment as standard efficiency or high efficiency? [ASK FOR EACH TECHNOLOGY]

01	Standard efficiency	
02	High efficiency	
88	Refused	
99	Don't know	

31. Does your cooling system have an Economizer? (READ AND RECORD)

01	Yes	
02	No	
88	Refused	
99	Don't know	

32. During the summer, how is the primary air-conditioning system typically operated at this facility? Is it operated… [READ]

01	24 hours a day	
02	During business operating hours	
03	Less than business operating hours	
04	Never	
77	Other (RECORD VERBATIM)	
88	Refused	
99	Don't know	

33. Which of the following control strategies or systems are used for the cooling system at this facility? Do you use… [READ, SELECT ALL THAT APPLY]

01	Energy Management System (EMS)	
02	Time clocks	
03	Standard thermostats	
04	Programmable thermostats	
05	Smart/Wi-Fi thermostats	
06	Variable-frequency drives on large fan motors or chilled water pumps	
07	None	
77	Other (record verbatim)	
88	Refused	
99	Don't know	

34. Over the past three years, have you made any changes related to the cooling system at this facility, including new air conditioner units, controls; or reflective window film?

01	Yes	
02	No changes (GO TO Q38)	
88	Refused (GO TO Q38)	
99	Don't know (GO TO Q38)	

35. What types of air conditioning equipment were installed as part of the cooling system changes? Did you install… [READ, SELECT ALL THAT APPLY]

01	Central chilled water plant equipment, where a large central cooling system is used to cool water that is then distributed to multiple locations. Includes chillers, pumps, cooling towers.	
02	Packaged central air conditioners, where the compressor, condenser, and supply air fan are contained in the same housing and located on the roof or on the ground outside of your building	
03	Split-system air conditioners made up of two components, where the compressor and condenser are located outside and the supply air fan is inside the building shell)	
04	Individual window or wall units, where all components located in same housing	
05	District Chilled water piped in from outside the building	
06	Central air-handling equipment, including changes to fans, volume controls, cooling and heating coils.	
77	Other (record verbatim)	
88	Refused	
99	Don't know	

36. What types of air conditioning **control** equipment were installed as part of the cooling system changes? Did you install... [READ] [ALLOW MULTIPLE ANSWERS]

01	Energy Management System (EMS)	
02	Time clocks	
03	Standard thermostats	
04	Programmable thermostats	
05	Smart/Wi-Fi thermostats	
06	None	
77	Other (record verbatim)	
88	Refused	
99	Don't know	

37. What **other** types of equipment, if any, were installed as part of the cooling system changes? Did you install... [READ] [ALLOW MULTIPLE ANSWERS]

01	Variable-frequency drives on large fan motors or chilled water pumps	
02	Reflective or tinted window film	
03	Economizers	
04	Cool roof replacing a standard roof	
05	NEMA Premium motors	
06	None	
77	Other (record verbatim)	
88	Refused	
99	Don't know	

IF Q6 = 17 THEN ASK Q38; ELSE SKIP TO NEXT SECTION

38. We have a couple of questions about the Data Centers in this facility. Does your server room have a dedicated Computer Room AC (CRAC)? [RECORD]

01	Yes (GO TO Q39)	
02	No (GO TO NEXT SECTION)	
06	None (GO TO NEXT SECTION)	
88	Refused (GO TO NEXT SECTION)	
99	Don't know (GO TO NEXT SECTION)	

39. Does this system have an economizer? [RECORD]

01	Yes	
02	No	
06	None	
88	Refused	
99	Don't know	

Space Heating

IF Q3 = 1 THEN ASK Q40; ELSE SKIP TO NEXT SECTION

40. Next, I'd like to ask you a few questions about your space heating equipment. Approximately what percentage of the space occupied by your business is heated during the winter months? [READ IF NECESSARY]

01	100 percent	
02	75 to 99 percent	
03	50 to 74 percent	
04	25 to 49 percent	
05	One to 24 percent	
06	None	
88	Refused	
99	Don't know	

41. What is the main fuel used in the heating system at this facility? [READ]

01	Electricity	
02	Natural gas	
03	LPG or Propane gas from a tank	
77	Other (record verbatim)	
88	Refused	
99	Don't know	

42. What is the primary type of heating system used with this fuel to heat this facility? [READ, SELECT ONE]

01	Central boiler	
02	Central furnace	
03	Packaged Terminal heating units, not including heat pumps	
04	Individual space heater, portable room heater, or strip heating	
05	Split-system heat pump made up of two components, where the compressor is located outside and the supply air fan is mounted on the wall or ceiling indoors	
06	District steam or hot water piped in from outside the building	
77	Other (record verbatim)	
88	Refused	
99	Don't know	

IF Q42 = 05 THEN ASK Q43; ELSE SKIP TO Q44

43. What type of Heat Pump is used at this facility? [READ]

01	Air-source heat pump	
02	Water-source heat pump	
03	Geothermal heat pump	
77	Other (specify)	
88	Refused	

99	Don't know	

44. Would you characterize the heating system as standard or high efficiency?

01	Standard efficiency	
02	High efficiency	
88	Refused	
99	Don't know	

45. Does your facility have heat recovery system (HRV) or energy recovery system (ERV)? [RECORD YES or NO]

01	Yes	
02	No	
88	Refused	
99	Don't know	

46. During the winter, how is the heating system typically operated at this facility? Is it operated… [READ]

01	24 hours a day	
02	During operating hours and set-back at night	
03	Only during operating hours	
04	Less than operating hours	
05	Never	
77	Other (specify)	
88	Refused	
99	Don't know	

47. Which of the following control strategies are used with the heating system at this facility? Do you use… [READ AND SELECT ALL THAT APPLY]

01	Energy Management System (EMS)	
02	Time clocks	
03	Standard thermostats	
04	Programmable thermostats	
05	Smart/Wi-Fi thermostats	
06	Variable-frequency drives on large fan motors or hot water pumps	
07	None	
77	Other (record verbatim)	
88	Refused	
99	Don't know	

48. Over the past three years, have any changes been made related to the heating system at this facility, including new heating units or controls?

01	Yes	
02	No changes (SKIP TO NEXT SECTION)	
88	Refused (SKIP TO NEXT SECTION)	
99	Don't know (SKIP TO NEXT SECTION)	

49. What types of equipment were installed as part of the heating system changes? [READ, SELECT ALL THAT APPLY]

01	Central boiler	
02	Central furnace	
03	Packaged heating units, not including heat pumps	
04	Individual space heater, portable room heater, strip heating	
05	Split-system heat pump made up of two components, where the compressor is located outside and the supply air fan is mounted on the wall or ceiling indoors	
06	District steam or hot water piped in from outside the building	
07	Designed Solar Technology	
77	Other (record verbatim)	
88	Refused	
99	Don't know	

If Q49 = (1, 2, 3, 4, 5, 6, 7), THEN ASK Q50; ELSE GO TO NEXT SECTION

50. What types of control equipment were installed as part of the heating system changes? Did you install... [READ, SELECT ALL THAT APPLY]

01	Energy Management System (EMS)	
02	Time clocks	
03	Standard thermostats	
04	Programmable thermostats	
05	Smart/Wi-Fi thermostats	
06	Variable-frequency drives on large fan motors or hot water pumps	
07	No controls	
77	Other (record verbatim)	
88	Refused	
99	Don't know	

Water Heating

51. Next, I'd like to ask a few questions about the water heating equipment at your business's facility. What is the main fuel used to provide hot water at this facility? [READ]

01	Electricity	
02	Natural gas	
03	LPG or propane gas from a tank	
77	Other (record verbatim)	
88	Refused	NEXT SECTION
99	Don't know	NEXT SECTION

52. What type of water heating system is used with this fuel to provide hot water at this facility? [READ, SELECT ALL THAT APPLY]

01	Central boiler	
02	Tank Water Heater	
03	Tankless water heaters	
04	Solar Thermal Water Heater	
77	Other (record verbatim)	
88	Refused	
99	Don't know	

53. Would you characterize the water heating system as standard or high efficiency?

01	Standard efficiency	
02	High efficiency	
88	Refused	
99	Don't know	

54. Over the past three years, have you installed new water heating units?

01	Yes	
02	No [SKIP TO NEXT SECTION]	
88	Refused [SKIP TO NEXT SECTION]	
99	Don't know [SKIP TO NEXT SECTION]	

55. Over the past three years, have you installed the following equipment? [READ]

		01	02	88	99
A	Pipe insulation	Yes	No	Refused	Don't know
B	Water heater wrap	Yes	No	Refused	Don't know
C	Water heater controls	Yes	No	Refused	Don't know

Refrigeration Equipment

56. Do you have any commercial refrigeration equipment at this facility?

01	Yes	
02	No	NEXT SECTION
88	Refused	NEXT SECTION
99	Don't know	NEXT SECTION

ASK IF Q56 = 1; ELSE SKIP TO NEXT SECTION

57. Which of the following types of refrigeration equipment is present at your facility? [READ LIST, SELECT ALL THAT APPLY]

01	Walk-in coolers or freezers	How many?
02	Refrigerated-Retail Display Cases	How many?
03	Residential-type solid-door refrigerators	How many?
04	Commercial-grade solid-door refrigerators	How many?
05	Commercial Ice Makers	How Many?
06	Other (Record Verbatim)	How Many?
88	Refused	
99	Don't know	

ASK IF Q57=1 or 2; ELSE SKIP TO NEXT SECTION

58. What percentage of the display cases, or walk-in coolers or freezers in your facility are low temperature, meaning they are set to temperatures below 32F?

01	Enter Percent ________________	
88	Refused	
99	Don't know	

ASK IF Q57=1; ELSE SKIP TO NEXT SECTION

59. What percentage of the walk-in coolers or freezers in your facility use Evaporator Fan Controllers?

01	Enter Percent ________________	
88	Refused	
99	Don't know	

ASK IF Q57 = 2; ELSE SKIP TO NEXT SECTION

60. To reduce the energy usage of your display cases, what percent of them use...? [READ LIST; % estimates for all that apply. Types are not mutually exclusive so do not need to add to 100%.]

	Measure	Percent
01	High efficiency Glass Doors	
02	Strip curtains	
03	Electronically commutated motors (ECMs) for evaporator fans	
04	Anti-Sweat Heater Controls	
05	Night Covers for refrigerated display cases	
06	LED Case Lighting (Strip lighting)	
77	Other (record verbatim)	
88	Refused	
99	Don't know	

MOTORS, VARIABLE SPEED DRIVES, AND PUMPS

Now I would like to ask a few questions about motors at this facility.

61. How many motors does this facility use for purposes other than air conditioning?

01	None	NEXT SECTION
02	Less than four	
03	Four or more but less than ten	
04	Ten or more but less than 25	
05	25 or more	
88	Refused	
99	Don't know	

62. What percentage of these motors are energy efficient? [ENTER PERCENT]

____

63. Do you generally purchase energy efficient motors, standard efficiency motors or have your motors rewound?

01	Energy efficiency motors	
02	Standard efficiency motors	
03	Rewind motors	
88	Refused	
99	Don't know	

64. How many variable speed drives does this facility use for purposes other than air conditioning?

01	None	
02	Less than four	
03	Four or more but less than ten	
04	Ten or more but less than 25	
05	25 or more	
88	Refused	
99	Don't know	

65. How many pumps does this facility use?

01	None	
02	Less than four	
03	Four or more but less than ten	
04	Ten or more but less than 25	
05	25 or more	
88	Refused	
99	Don't know	

Other Equipment

66. Is any of the following equipment used at your facility? [READ, YES/NO]

		Yes	No
01	Commercial-grade electric cooking equipment		
02	Commercial-grade gas cooking equipment		
03	Electric pool heaters		
04	Gas pool heaters		
05	Electric spa heaters		
06	Gas spa heaters		
07	Refrigerated vending machines		
08	Non-refrigerated vending machines		
09	Backup or emergency electric generators		
10	Industrial motors or pumps		
11	Industrial process equipment		
77	Other (record verbatim)		
88	Refused		
99	Don't know		

67. Is this equipment considered energy efficient (versus standard efficiency)? [ONLY FOR EACH YES IN Q66, SELECT ONE FROM ALL, SOME, NONE]

		All	Some	None
01	Commercial-grade electric cooking equipment			
02	Commercial-grade gas cooking equipment			
03	Electric pool heaters			
04	Gas pool heaters			
05	Electric spa heaters			
06	Gas spa heaters			
07	Refrigerated vending machines			
08	Non-refrigerated vending machines			
09	Backup/emergency electric generators			
10	Industrial motors or pumps			
11	Industrial process equipment			
77	Other (record verbatim)			
88	Refused			
99	Don't know			

ASK IF Q66 = 01 or 02; ELSE SKIP TO NEXT SECTION

68. Does your facility have the following kitchen equipment? [READ AND RECORD]

		Yes	No
01	Combination Ovens	How many?	
02	Convection Ovens	How many?	
03	Conveyer Ovens	How many?	
04	Rack Ovens	How many?	
05	Dishwashers	How many?	
06	Fryers	How many?	
07	Exhaust Hood	How many?	
08	Pressure-less Steamer	How many?	
09	Steam Cooker	How many?	
77	Other (record verbatim)		
88	Refused		
99	Don't know		

OTHER EFFICIENCY-RELATED IMPROVEMENTS

Finally, I'd like to ask you a few questions about any energy-efficiency actions you may have considered during the past two years that were not implemented.

69. In the last two years, did your organization plan any energy efficient actions to reduce energy consumption that were not implemented?

01	Yes	
02	No (skip to Q71)	
88	Refused (skip to Q71)	
99	Don't know (skip to Q71)	

70. What specific actions to improve energy efficiency or reduce energy consumption were identified but not implemented?

01	RECORD VERBATIM	
88	Refused	
99	Don't know	

ASK IF Q69 = 02, 88 or 99; ELSE SKIP TO Q72

71. What were the primary reasons that you did not take these energy saving actions? [DO NOT READ. SELECT ALL THAT APPLY. ALLOW VERBATIM RECORDING.]

01	Other priorities for capital spending	
02	Amount of savings did not justify added investment costs	
03	No funds available for investment	
04	Energy savings were too uncertain	
05	Could not obtain financing for investment	
06	Needed more information to make decision or convince management	
07	Not enough management time to oversee project	
08	Would have taken too much time to get a convincing analysis	
09	Do not pay the electric or gas bill	
77	Other (record verbatim)	
88	Refused	
99	Don't know	

72. Does your organization have any plans to invest capital in energy efficiency equipment at this facility during the next 2 years?

01	Yes	
02	No	
88	Refused	
99	Don't know	

ASK IF Q72=1; ELSE SKIP

73. What do you plan to invest in during the next two years? [OPEN ENDED]

____

Thank You & Terminate

Thank you for taking the time to speak with me. Xcel Energy is planning to visit a few customer commercial, industrial and agricultural facilities to gather more information on energy efficiency equipment. The visit would be complimentary and might provide you with information on how to increase the efficiency of your operation. Would you be interested in a phone call to discuss the added survey effort?

01	Yes	
02	No	
88	Refused	
99	Don't know	

That's all the questions that we have. On behalf of Xcel Energy, I'd like to thank you very much for taking the time to participate in this study.

C.2 Detailed Survey Results

See attachment, "Xcel Energy_2016 DSM Potential Study Complete Crosstabs_11-01-16.xlsx," for the final C&I survey results, which incorporate the results from both the phone and onsite surveys.

APPENDIX D. UPSTREAM MARKET ACTOR SURVEY RESULTS

This appendix includes the final survey instrument used for the upstream market actor survey, as well as the final market actor survey results.

D.1 Survey Instrument

Xcel Energy 2016 DSM Potential Study – Upstream Phone Survey Guide
DRAFT – May 2016

1.1 Objectives

The purpose of the interview is to collect qualitative data to inform parallel efforts of data collection on measures and savings potential in Xcel Energy's Colorado territories.

Not all respondents will have experience in all of the study's areas of interest (see Figure 57 below). As appropriate, throughout the interview Navigant will tailor questions to match the interviewee's background as characterized in section **Error! Reference source not found.**.

Figure 57. Areas of Interest for DSM Potential Study

Areas of Interest	Categories
Sector	Residential; Commercial; Industrial/Agricultural
Customer Segment	Single Family; Multifamily; Office; Manufacturing, etc.
End Use	Lighting; HVAC; Motors; EMS Control; etc.

1.2 Interview

Contact Summary	
Contact Name	
Contact Job Title	
Contact Organization	
Contact Sector/Customer Segment	
Date and Time	
Interviewer	

Hello, this is [INSERT NAME HERE] calling from Navigant Consulting on behalf of Xcel Energy. Xcel Energy has contracted with Navigant to conduct market research on energy efficiency technologies in the state of Colorado, and as part of that research we are reaching out to market actors such as yourself to ask a few questions and better inform our understanding of the energy efficiency landscape.

This call is for informational purposes only and at no point will I try to sell you anything.

Your input will provide Xcel Energy with a better understanding of the current market for efficient technologies and will help Xcel Energy improve its energy efficiency programs going forward. Your individual responses will remain confidential and we will only report results to Xcel Energy in aggregate. As a thank you for participating in this study, we would be happy to provide you with a copy of the final report, which will provide an overview of what others such as yourself are saying about the market.

Can I please speak with [CONTACT NAME IF AVAILABLE; OR "the person in your company most knowledgeable on the market for energy efficiency products"]? [If needed, clarify the types of sectors, customer segments, and end uses we are interested in]

My questions should take about 15 minutes, is now a good time for us to talk? [IF YES – PROCEED WITH INTERVIEW]
[IF NO] When would be a good time in your schedule for me to call back? [SET TIME].

1.2.1 Background

1) To begin with, our records show that your company specializes in [INSERT SPECIALIZATION HERE]. Is that correct? [Confirm or record actual specialization]
2) Could you please describe your position and responsibilities related to energy efficiency equipment or demand side management? [Probe for context on sector, customer segment, and end use]
3) How long have you held this or a related position?

1.2.2 Customer Awareness of Energy Efficient Technologies

[*Note to interviewer – for the following questions, the goal is to focus on the most/least well-known measures (if familiar with) and technologies regardless of adoption, cost effectiveness or saturation in the market. If the respondent is uncertain about what parameters to use, please provide this context.*]

4) [RES SECTOR ONLY] From the customer's perspective, what are the three most well-known energy efficient measures or technologies in the residential market? What are the three least-known?
5) [COMM SECTOR ONLY] From the customer's perspective, what are the three most well-known energy efficient measures or technologies in the commercial market? What are the three least-known?
6) [IND/AG SECTOR ONLY] From the customer's perspective, what are the three most well-known energy efficient measures or technologies in the industrial/agricultural market? What are the three least-known?

1.2.3 Sales and Influences on Sales

7) What do you see as the biggest barriers preventing more widespread uptake of efficient measures and technologies?

1.2.4 Costs

8) [RES SECTOR ONLY] For the residential market, what are the three measures or technologies you anticipate will decline the most in price (relative to current price) over the next five years? What about the next ten years?
9) [COMM SECTOR ONLY] For the commercial market, what are the three measures or technologies you anticipate will decline the most in price (relative to current price) over the next five years? What about the next ten years?
10) [IND/AG SECTOR ONLY] For the industrial/agricultural market, what are the three measures or technologies you anticipate will decline the most in price (relative to current price) over the next five years? What about the next ten years?
11) What do you suspect will be the main drivers behind that decline in price? [As appropriate reference all of the above measures/technologies] [Examples: Economies of scale, increased up-take in the market, technological breakthroughs, etc.]
12) [For each measure/technology mentioned]
    - How would you describe the magnitude of that expected decrease in price over the next five years? Would you characterize it as a small, medium, or large decrease?

1.2.5 Savings/Efficiency and Future Changes

13) [RES SECTOR ONLY] Which technologies do you anticipate will have the greatest increases in efficiency in the residential sector over the next five years? What about the next ten years?
14) [COMM SECTOR ONLY] What about for the commercial sector? [Note – repeat original question as necessary and based on sector experience]
15) [IND/AG SECTOR ONLY] What about for the industrial/agricultural sector? [Note – repeat original question as necessary and based on sector experience]
16) [For each measure mentioned]
    - How would you describe the magnitude of that expected increase in efficiency? Would you characterize it as small, medium, or large?
17) What three measures do you anticipate will increase the most in adoption over the next five years?

1.2.6 Role of the Utility

18) Have utility programs had an effect on customer uptake of any of these technologies? Which technologies in particular have been most/least impacted by utility programs?

1.2.7 Marketing Effectiveness

19) On a scale of 1 to 10, how effective do you consider Xcel Energy's current energy efficiency marketing efforts in terms of encouraging greater customer uptake of efficient technologies, where 10 is extremely effective? [Note that this is not a question about how much effort or funding is currently being put into marketing, but rather how effectively the current level of effort and funding are used and how well that translates into impact on customers]
    - Why did you give that rating?

1.2.8 Conclusion

20) Do you have any other observations about the future energy efficiency market or potential for efficient technologies in Xcel Energy's territory that we have not yet touched on and you would like to share?
21) Would you like us to send you a copy of the final report for this study, when it becomes available?

- If yes, please provide the following:

Name	
Email	

Thank you for your time and your valuable input.

D.2 Detailed Survey Results

The tables below provide a summary of market actor input on the following: end user awareness of efficient measures/technologies; measure/technology declines in price; greatest increases in efficiency; and measure/technology increases in adoption.

Navigant asked market actors to comment on which measures they thought end users had the most and least familiarity.

Table 36 shows that lighting measures and HVAC equipment are generally well known in both the residential and commercial sectors, with many of the market actor responses referencing lighting for this question specifically mentioned LEDs. Residential customers are also familiar with insulation measures and commercial customers are familiar with motors and drives. Air sealing and water heater equipment are generally less well known in the residential sector.

Table 36. End User Awareness of Efficient Technologies/Measures

	Residential		Commercial		Industrial	
Measures	Most Well Known	Least Well Known	Most Well Known	Least Well Known	Most Well Known	Least Well Known
Lighting	6	2	11	1	1	
HVAC	4	1	5			
Motors and Drives			4	2	1	
Solar PV[40]			3			
VFD			3	3		
Boilers	1		2			
Chillers			2			
EMS			1			
Ice Storage			1			
Occupancy Sensors			1			
Pre-cooling Systems			1			
Storage (Batteries)			1			
Thermostats			1			
VRF			1			
Insulation	5	1				
Evaporative Coolers	3	1				
Furnaces	3					
Appliances	2					
Water Heaters	2	3				
Air Sealing	1	4				
Energy Audits	1					
Windows	1					
Ground Source Heat Pumps				1		
Natural Ventilation				1		
Radiant Cooling and Heating				1		
Shower Aerators		1				
Smart Metering				2		
Ventilation		1				

[40] Questions to market actors were open-ended, so some market actors responded more broadly about other distributed energy resources, beyond energy efficiency. These responses are included here for completeness.

Whole House Fans	1		
Window Coverings	1		
VSD		1	1
Soft Starters			1

Source: Navigant Market Actor Surveys 2016; n=26; Multiple responses accepted. Table provides count of mentions by market actors.

Navigant additionally asked market actors to comment on which measures they anticipate would decrease the most in price over the next five and ten years. Table 37 shows that there is relative consensus that LED bulbs will decline in price in the coming five years, as well as HVAC technology in the residential sector. For the commercial sector, several market actors indicated an expected price drop in Solar PV and ECM motor technology.

Table 37. Measures/Technologies Predicted to Decline Most in Price

	Residential		Commercial		Industrial	
Measures	**Next 5 Years**	**Next 10 Years**	**Next 5 Years**	**Next 10 Years**	**Next 5 Years**	**Next 10 Years**
LEDs	6	3	8	3		
HVAC	4	4	2	1		
Water Heaters	2	2				
Solar PV	2		3	2		
Appliances	1	2				
Insulation	1					
Refrigerant	1	1				
Windows	1					
Doors	1					
ECM Motors			3	1		
VFD			2	1		
EMS			2			
Lighting Controls			2	2		
Evaporative Cooling			1			
VRF			1			
Wind				1		
Storage				1		
Motor Controls				1		
Heat Recovery from Waste Water				1		
VSDs					1	
Soft Starts					1	
Valve Tech					1	
PLC Tech					1	
Premium efficient motor tech						1
Harmonic mitigation						1

Source: Navigant Market Actor Surveys 2016; n=26; Multiple responses accepted. Table provides count of mentions by market actors.

To follow up on the decline in price, Navigant also asked market actors which measures or technologies they expect to increase the most in efficiency over the next five and ten years, respectively. Similar to expected decreases in price, market actors in both the residential and commercial sectors predict that LED bulbs will see a large increase in efficiency in the coming years. HVAC equipment and building controls are also predicted to experience notable increases in efficiency.

Table 38. Measures/Technologies Predicted to Increase in Efficiency

	Residential		Business		Industrial	
Measures	Next 5 Years	Next 10 Years	Next 5 Years	Next 10 Years	Next 5 Years	Next 10 Years
LEDs	3	2	7	5		
Insulation	3		1			
Water Heaters	3	2				
Furnaces	2	1				
HVAC	4	3	2			
Air Sealing	2					
Boilers	2					
Appliances	1	1				
Audits	1					
Whole House Fans	1					
Heat Pumps	1					
New Build Platforms	1					
Tankless Water Heaters		1				
EMS/Controls		1	3	1		
Refrigerators		1				
VFD			1			
Chillers			1			
Building Design/LEED				1		
Storage Technology				2		
Windows/Doors				1		
Electric Motors					1	
Permanent magnet motors					1	
VSD						1
Motion Control					1	
Low Harmonic Solutions					1	

Source: Navigant Market Actor Surveys 2016; n=26; Multiple responses accepted. Table provides count of mentions by market actors.

Finally, taking into account current awareness and expected changes to price and efficiency, Navigant asked market actors to share their predictions for which measures or technologies would increase the most in adoption over the next five years. Once again, market actors working in Xcel Energy's Colorado territory expect to see widespread adoption of LED bulbs and HVAC technology, followed by lighting controls, Solar PV technology, and VFD.

Table 39. Measures/Technologies Predicted to Increase Most in Adoption over the Next Five Years

Measure	Mentions
LED	12
HVAC	6
Lighting Controls	4
Solar PV	4
VFD	3
Wind	2
VRF	2
Ductless Mini-Splits	2
Storage	2
Permanent Magnet Motors	2
Insulation	1
Occupancy Sensors	1
Evaporative Coolers	1
Auditing	1
Pack walls w/ Fiberglass	1
Air Sealing	1
EVs	1
ECM	1
Space Heating	1
Behavioral Changes	1

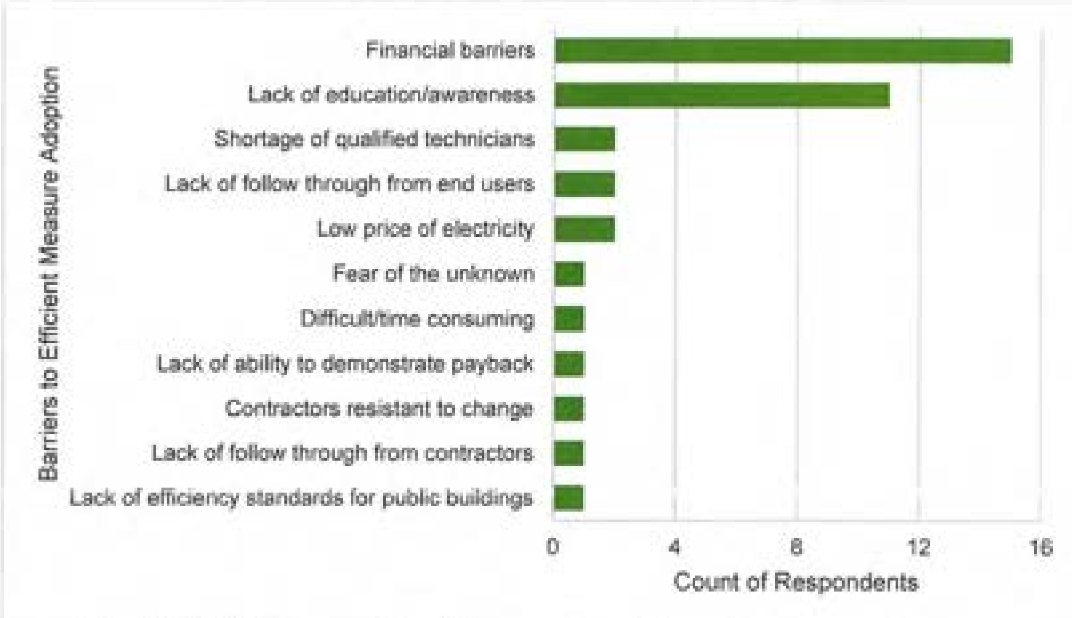
Source: Navigant Market Actor Surveys 2016; n=26; Multiple responses accepted. Table provides count of mentions by market actors.

In addition to the data discussed above, the evaluation team asked market actors to share their opinion on other factors affecting the energy efficiency market in Colorado.

When it comes to barriers affecting an increase in adoption for energy efficient measures, respondents overwhelmingly commented on the financial barriers and lack of education and awareness amongst end users (see Figure 58). For many end users, the upfront costs of purchasing and installing high efficiency measures are an obstacle, or the proper business models are not in place to accommodate an extended return on investment (ROI). As one market actor stated, "customers want to save energy/electricity and purchase units that are better for the environment, but costs are not 'convenient' for most customers to make those choices." Of the 15 market actors who mentioned this barrier, 10 associate with the commercial sector, suggesting that financial barriers presents more of an issue for commercial end users.

Additionally, 11 market actors across both the commercial and residential sectors commented on a lack of end user education as a major barrier to efficient measure adoption. End users may be unaware of what options are available to them, or may be unclear about the benefits of various technologies or measures. Figure 58 below provides a list of other barriers mentioned by market actors.

Figure 58. Barriers to Energy Efficient Measure Adoption

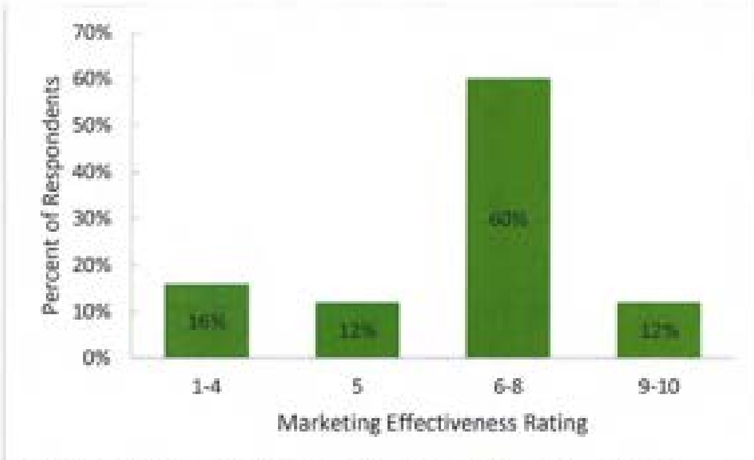


Source: Navigant Market Actor Surveys, n=26; multiple responses accepted

The evaluation team also asked market actors to rank the effectiveness of Xcel Energy's marketing efforts in encouraging greater customer uptake of efficient technologies. The majority of respondents ranked Xcel Energy's marketing effectiveness between a 6 and an 8, on a scale from 1 to 10 where 10 is extremely effective. Figure 59 shows that 72 percent of respondents rated Xcel Energy's marketing effectiveness at a 6 or higher, while 16 percent rated the effectiveness at a 4 or lower. The finding above that market actors see lack of education/awareness as the second largest barrier to adoption suggests that, while most market actors generally feel Xcel Energy's marketing is more effective than not, there is still room for improvement.

For those respondents who provided a low rating on the marketing effectiveness, several market actors commented on the lack of customer familiarity with Xcel Energy's programs, noting that retail stores or contractors are generally familiar with the programs but that this does not always translate down to the customers. One market actor also noted that they regularly encounter administrative issues and it can be difficult to receive a rebate.

Figure 59. Effectiveness of Xcel Energy's Marketing Efforts



Source: Navigant Market Actor Surveys, n=25; Asked on a scale from one to ten

APPENDIX E. MEASURE CHARACTERIZATION DATA

E.1 Measure List

See attachment, "Xcel Energy_2016 DSM Potential Study Measure List_Final.xlsx," for the full list of measures considered for the study (see the "Full Scan" tabs), as well as the final list of measures used in the study (see the "List" tabs).

E.2 Measure Characteristics Data File

See tab "Measure Appendix" in attachment, "Xcel Energy_2016 DSM Potential Study Report_FiguresAndTables_All_LIVE.xlsx," for granular measure input to the DSMSim™ model.

The tables below also provide more detailed information on the assumptions used in the analysis for the impacts of codes and standards on measure savings over time, as well as reductions in technology costs that are expected to impact certain measures over the study period.

Table 40. Codes and Standards Savings Multipliers by Measure

Measure	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
COM | Air Source Heat Pump - CZ 5	1.000	1.000	0.890	0.890	0.890	0.890	0.890	0.890	0.890	0.890	0.890	0.890	0.890
COM | Air Source Heat Pump - CZ 6	1.000	1.000	0.890	0.890	0.890	0.890	0.890	0.890	0.890	0.890	0.890	0.890	0.890
COM | Air Source Heat Pump - CZ 7	1.000	1.000	0.890	0.890	0.890	0.890	0.890	0.890	0.890	0.890	0.890	0.890	0.890
Com | CFL Fixture - Interior	1.000	1.000	1.000	1.000	0.317	0.317	0.317	0.317	0.317	0.317	0.317	0.317	0.317
Com | Commercial Ice Makers	1.000	1.000	1.000	0.920	0.920	0.920	0.920	0.920	0.920	0.920	0.920	0.920	0.920
Com | ECM Fan Motor System - Display Case ROB/NEW	1.000	0.707	0.707	0.707	0.707	0.707	0.707	0.707	0.707	0.707	0.707	0.707	0.707
Com | ECM Fan Motor System - Refrigerated Walk-In ROB/NEW	1.000	1.000	1.000	1.000	1.000	0.707	0.707	0.707	0.707	0.707	0.707	0.707	0.707
Com | LED Fixture – Interior	1.000	1.000	1.000	1.000	0.317	0.317	0.317	0.317	0.317	0.317	0.317	0.317	0.317
COM | Packaged Terminal AC (PTAC) Equipment - CZ 5	1.000	0.923	0.923	0.923	0.923	0.923	0.923	0.923	0.923	0.923	0.923	0.923	0.923
COM | Packaged Terminal AC (PTAC) Equipment - CZ 6	1.000	0.923	0.923	0.923	0.923	0.923	0.923	0.923	0.923	0.923	0.923	0.923	0.923
COM | Packaged Terminal AC (PTAC) Equipment - CZ 7	1.000	0.923	0.923	0.923	0.923	0.923	0.923	0.923	0.923	0.923	0.923	0.923	0.923
Com | Screw-In CFL - Interior (High)	1.000	1.000	1.000	1.000	0.280	0.280	0.280	0.280	0.280	0.280	0.280	0.280	0.280
Com | Screw-In CFL - Interior (Low)	1.000	1.000	1.000	1.000	0.302	0.302	0.302	0.302	0.302	0.302	0.302	0.302	0.302
Com | Screw-In LED - Interior (High)	1.000	1.000	1.000	1.000	0.280	0.280	0.280	0.280	0.280	0.280	0.280	0.280	0.280
Com | Screw-In LED - Interior (Low)	1.000	1.000	1.000	1.000	0.302	0.302	0.302	0.302	0.302	0.302	0.302	0.302	0.302
COM | SEER Rated Split or Rooftop AC - CZ 5	1.000	1.000	0.850	0.850	0.850	0.850	0.850	0.850	0.850	0.850	0.850	0.850	0.850
COM | SEER Rated Split or Rooftop AC - CZ 6	1.000	1.000	0.850	0.850	0.850	0.850	0.850	0.850	0.850	0.850	0.850	0.850	0.850
COM | SEER Rated Split or Rooftop AC - CZ 7	1.000	1.000	0.850	0.850	0.850	0.850	0.850	0.850	0.850	0.850	0.850	0.850	0.850
Res | ENERGY STAR CFL Bulbs (General Service Lamps) 13-18W	1.000	1.000	1.000	1.000	0.360	0.360	0.360	0.360	0.360	0.360	0.360	0.360	0.360
Res | ENERGY STAR CFL Bulbs (General Service Lamps) 19-22W	1.000	1.000	1.000	1.000	0.387	0.387	0.387	0.387	0.387	0.387	0.387	0.387	0.387
Res | ENERGY STAR CFL Bulbs (General Service Lamps) 23-30W	1.000	1.000	1.000	1.000	0.368	0.368	0.368	0.368	0.368	0.368	0.368	0.368	0.368
Res | ENERGY STAR CFL Bulbs (General Service Lamps) 7-12W	1.000	1.000	1.000	1.000	0.328	0.328	0.328	0.328	0.328	0.328	0.328	0.328	0.328
Res | Energy Star Clothes Washer	1.000	1.000	0.746	0.746	0.746	0.746	0.746	0.746	0.746	0.746	0.746	0.746	0.746
Res | LED (General Service Lamps) <=10W, 29W base	1.000	1.000	1.000	1.000	0.328	0.328	0.328	0.328	0.328	0.328	0.328	0.328	0.328
Res | LED (General Service Lamps) <=10W, 43W base	1.000	1.000	1.000	1.000	0.360	0.360	0.360	0.360	0.360	0.360	0.360	0.360	0.360

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Measure	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Res | LED (General Service Lamps) >10W, 53W base	1.000	1.000	1.000	1.000	0.387	0.387	0.387	0.387	0.387	0.387	0.387	0.387	0.387
Res | LED (General Service Lamps) >10W, 72W base	1.000	1.000	1.000	1.000	0.368	0.368	0.368	0.368	0.368	0.368	0.368	0.368	0.368

Source: Navigant 2016.

Table 41. Cost Reduction Multipliers by Measure

Measure	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Com | Exterior LED	0.922	0.863	0.817	0.781	0.752	0.742	0.734	0.729	0.725	0.722	0.720	0.718	0.717
Com | LED Fixture - Interior	0.922	0.863	0.817	0.781	0.752	0.742	0.734	0.729	0.725	0.722	0.720	0.718	0.717
Com | LED Fixture (T12 Base)	0.922	0.863	0.817	0.781	0.752	0.742	0.734	0.729	0.725	0.722	0.720	0.718	0.717
Com | LED Fixture (T8 Base) RET	0.922	0.863	0.817	0.781	0.752	0.742	0.734	0.729	0.725	0.722	0.720	0.718	0.717
Com | LED Fixture (T8 Base) ROB	0.922	0.863	0.817	0.781	0.752	0.742	0.734	0.729	0.725	0.722	0.720	0.718	0.717
Com | Screw-In LED - Interior (High)	0.922	0.863	0.817	0.781	0.752	0.742	0.734	0.729	0.725	0.722	0.720	0.718	0.717
Com | Screw-In LED - Interior (Low)	0.922	0.863	0.817	0.781	0.752	0.742	0.734	0.729	0.725	0.722	0.720	0.718	0.717
Res | LED (General Service Lamps) <=10W, 29W base	0.937	0.874	0.811	0.748	0.685	0.654	0.623	0.592	0.561	0.531	0.500	0.469	0.438
Res | LED (General Service Lamps) <=10W, 43W base	0.937	0.874	0.811	0.748	0.685	0.654	0.623	0.592	0.561	0.531	0.500	0.469	0.438
Res | LED (General Service Lamps) >10W, 53W base	0.937	0.874	0.811	0.748	0.685	0.654	0.623	0.592	0.561	0.531	0.500	0.469	0.438
Res | LED (General Service Lamps) >10W, 72W base	0.937	0.874	0.811	0.748	0.685	0.654	0.623	0.592	0.561	0.531	0.500	0.469	0.438
Res | LED (Reflector) <=15W, 29W base	0.904	0.807	0.711	0.614	0.518	0.483	0.449	0.415	0.381	0.347	0.313	0.279	0.245
Res | LED (Reflector) <=15W, 43W base	0.904	0.807	0.711	0.614	0.518	0.483	0.449	0.415	0.381	0.347	0.313	0.279	0.245
Res | LED (Specialty, Non-Reflector) <=5W, 29W base	0.937	0.874	0.811	0.748	0.685	0.660	0.635	0.610	0.585	0.560	0.535	0.510	0.484
Res | LED (Specialty, Non-Reflector) >5W, 150W base	0.937	0.874	0.811	0.748	0.685	0.660	0.635	0.610	0.585	0.560	0.535	0.510	0.484
Res | LED (Specialty, Non-Reflector) >5W, 43W base	0.937	0.874	0.811	0.748	0.685	0.660	0.635	0.610	0.585	0.560	0.535	0.510	0.484
Res | LED (Specialty, Non-Reflector) >5W, 53W base	0.937	0.874	0.811	0.748	0.685	0.660	0.635	0.610	0.585	0.560	0.535	0.510	0.484
Res | LED (Specialty, Non-Reflector) >5W, 72W base	0.937	0.874	0.811	0.748	0.685	0.660	0.635	0.610	0.585	0.560	0.535	0.510	0.484

Source: Navigant 2016.

APPENDIX F. STAKEHOLDER PRESENTATIONS

Navigant provided the presentations below to internal (i.e., Xcel-only) stakeholders and external (i.e. local Colorado region) stakeholders over the course of the project.

F.1 Internal Stakeholder Presentation (February 2016)

See PDF attachment for the February 8, 2016 internal stakeholder presentation:

F.2 External Stakeholder Presentation (February 2016)

See PDF attachment for the February 17, 2016 external stakeholder presentation:

F.3 External Stakeholder Presentation (August 2016)

See PDF attachment for the August 17, 2016 external stakeholder presentation:

APPENDIX G. SUPPORTING DATA FOR CHARTS

See attachment, "Xcel Energy_2016 DSM Potential Study Report_FiguresAndTables_All_LIVE.xlsx," for the complete results for electric energy, electric demand, and gas energy technical, economic, and achievable potential.